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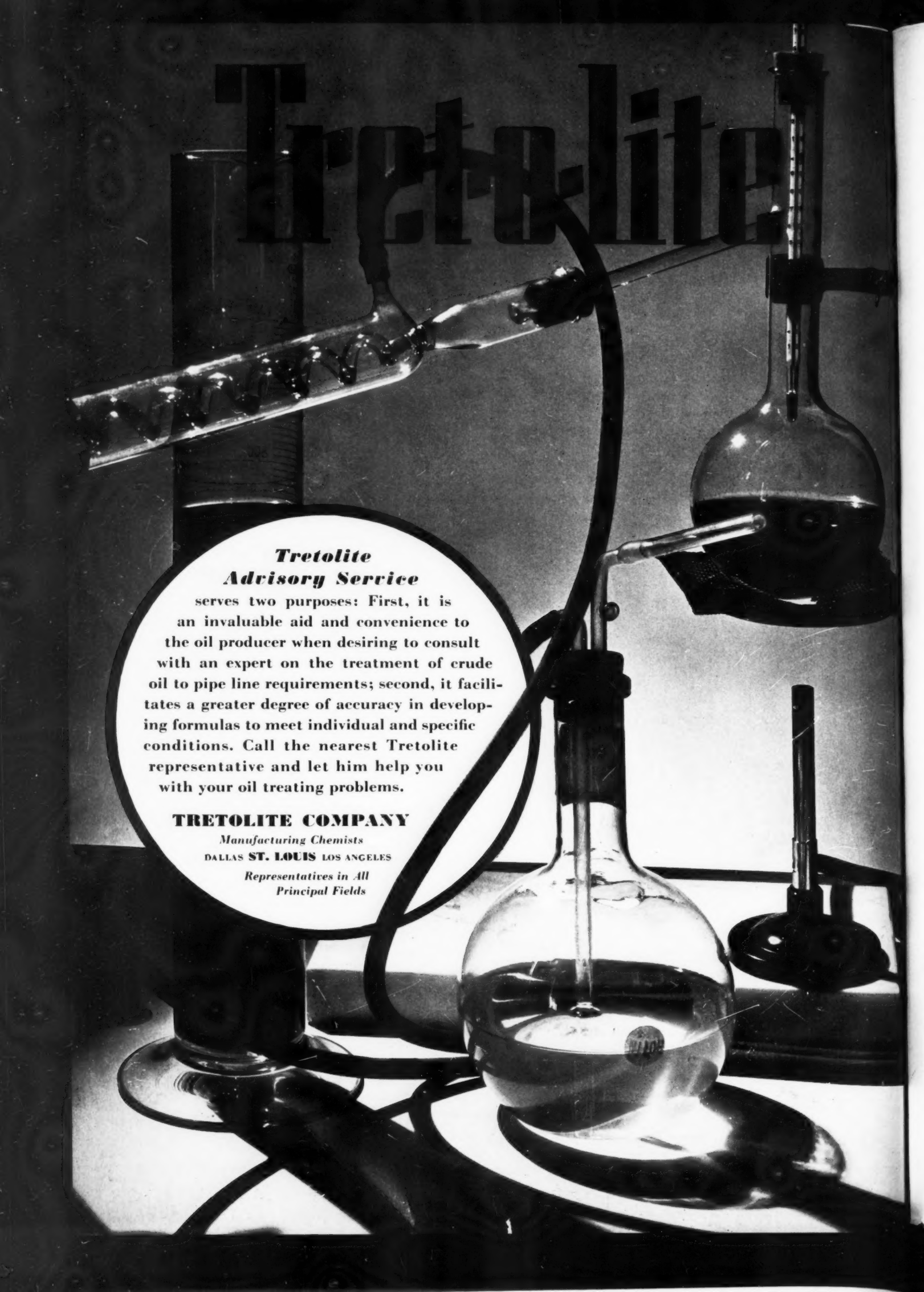
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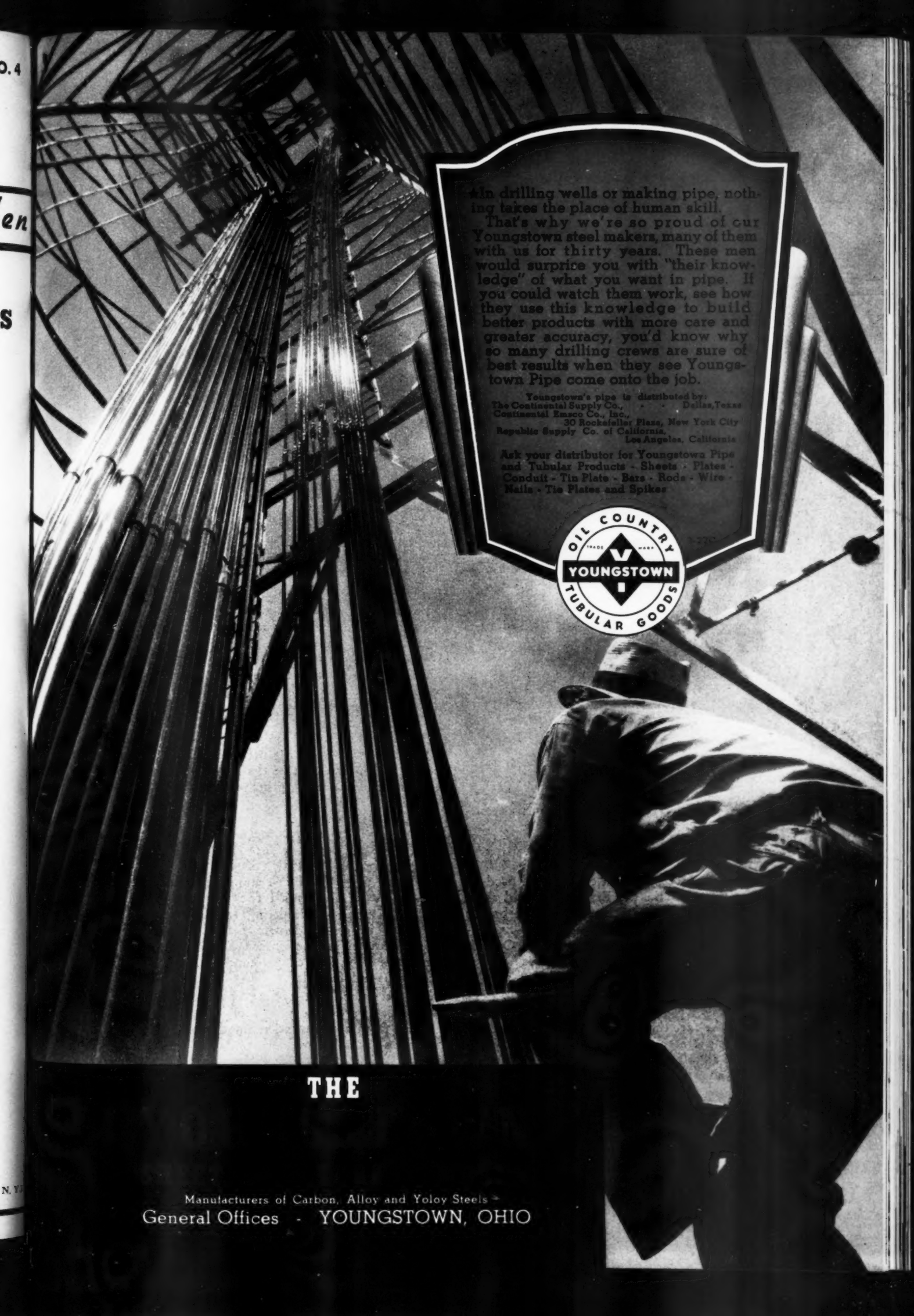
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The Course of Oil

By K. C. SCLATER

Discourage Federal Control

Resolutions have been passed by the Oil Producers Agency of California to the effect that it will be helpful to the conservation of petroleum and gas for California to become a party to the Interstate Oil Compact. In announcing its action, the Oil Producers Agency feels that California's "joining the Compact might place another stumbling block in the path of Federal control of the oil industry. Federal control is opposed not only because of its stifling effect on the oil industry itself, but also because it will complete the picture of Federal control over all sources of power, hence over all industry." It is also felt "that California's adherence to the Compact will give encouragement to present member-states who feel, rightly or wrongly, that they have borne the brunt of conservation efforts without proper support from California, the second largest oil-producing state." Lastly, it is believed that "attendance and participation in the meetings of the Compact Commission will be helpful not only to California, but also to all the other producing states, since the Compact is purely voluntary and since we (California) have had much experience in voluntary conservation programs."

Among the uncertainties clouding the outlook in the petroleum industry for 1941 is the threat of Federal control as proposed in the Cole Bill.

Proponents of Federal control of the oil industry might well ponder a statement of the United States Supreme Court. In the majority opinion handed down recently in the case of proration of production in the East Texas field by the Railroad Commission of Texas, one statement in the opinion sets forth that "A state's interest in the conservation and exploitation of a primary natural resource is not to be achieved through assumption by the federal courts of powers plainly outside their province and no less plainly beyond their special competence."

●

Water Encroachment's Toll

Recent official estimates of production in the East Texas field show that for each one hundred barrels of oil produced about fifty-six barrels of salt water is brought to the surface. Of this quantity of water, about twelve barrels is returned to the reservoir through injection wells. Almost all this salt water is produced by wells along the west edge of the field.

Aside from the fact that salt water shortens the life of his wells, the operator is also faced with the problem of disposing of all salt water produced without causing pollution. As an economy measure, several operators are planning to deepen a number of wells now producing some oil and so convert them into salt-water injection wells. There are at least twenty-seven salt-water disposal wells of this type now in operation.

Here is one increasing item of expense that confronts operators with wells along the west edge of the field. It drives home the wisdom of reducing or preventing water encroachment by conserving gas energy and thus reaping a fuller advantage of the water drive in the field. When the reservoir pressure declines at too great a rate, water encroachment is accelerated and the advantages of a water drive lost or seriously impaired. Despite the rigid curtailment of withdrawals from the reservoir that has been in force in the East Texas field, water encroachment from the west is taking its toll. Manifestly, this toll would have been increased many fold had the control been less rigid.

●

Hawkins Field Regulation

The discovery of a new oil field near Hawkins in East Texas has caused some excitement among East Texas oilmen in the area. Ten thousand or more acres has been mentioned as the probable extent of the field, but this figure is highly problematical. Its size will not be definitely known until the field has been further developed. The size of the field is likely to be large enough that it may have to be reckoned with so far as its ability to produce is concerned.

A reasonably wide well-spacing program strictly adhered to should keep development of the field from getting out of hand. There is every reason to believe that the present Railroad Commission will see to it that there are no exceptions to Rule 37, such as have been granted so readily in the East Texas field. By following a non-vacillating policy of regulating development and production in the Hawkins field according to sound engineering principles, the Railroad Commission can render a signal service to the State, the public, and the petroleum industry.

●

Condensate and Proration

Proration of gas condensate production in Texas is being advocated by a small faction in the industry. Considering the fact that cycling operations in gas-condensate fields are perhaps the most efficient of production conservation practices, the clamor for proration of gas-condensate products appears to be indefensible.

The very fact that cycling operations in gas-condensate fields are among the most efficient production methods from a conservation standpoint and compare more than favorably with other oil- and gas-producing operations, is a good and sufficient reason for encouraging this type of operation. An unbiased study of the economics of gas-condensate cycling projects will reveal the justness and wisdom of encouraging these operations, the proper control of which is adequately provided for in present state oil regulations.

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« « HIGHLIGHTS IN OILDOM » »

Cole Asks Life of Committee Be Extended

William P. Cole, Jr., sponsor of the Cole Bill proposing federal control of the oil industry, and chairman of the subcommittee of the House Interstate and Foreign Commerce Committee that investigated the oil industry during the last session of Congress, presented a resolution in the House of Representatives early this month asking that the life of his committee be extended until May 1. Cole explained that this extension is desired in order that additional hearings may be held to investigate the oil industry in relation to the national defense program. If granted, hearings will be held the latter part of January and February at which members of the National Defense Advisory Commission and various experts in their employ as advisers will be asked to testify.

Cole's request that his committee be continued, and the additional hearings, are looked upon by supporters of federal control as a plan to push the Cole Bill for final passage early in the new Congress. On the other hand, opponents saw in the proposal an effort to develop additional testimony that might be used in blocking efforts to bring about federal control.

Members of the defense commission are known to be unfavorable to federal control and have made statements to the effect that the organization of the oil industry on its present basis is such that its close coöperation in the defense program can be facilitated and that any disintegration of the present machinery of organization would curtail production and delivery both of crude oil and its refined products.

Representative Cole also is known to be opposed to federal control as sought by the administration. He introduced the bill at the request of President Roosevelt after it had been drafted by attorneys in the Department of Interior. Secretary of Interior, Harold L. Ickes, is the father of the federal control idea and has urged enactment of the legislation. Cole has intimated that he will not reintroduce his bill in the same form but that it may be changed materially.

●

Ten Texas Shutdown Days In January

An order issued early in the month by the Texas Railroad Commission that wells be closed-in January 8 brought the total number of shutdown days for the month to ten. The general statewide proration order governing December and January called for nine shutdown days each month except for wells that would suffer physical damage. The number of shutdown days for December was also increased to ten by an order made subsequent to the commission's original order.

●

Refuses to Make Price a Factor in Gas Allowables

The Kansas Corporation Commission has refused to impose price control as a factor in gas allowables in an order denying an application by the Drillers Gas Company for modification of proration rules for the Cunningham gas pool of Pratt and Kingman counties.

"The applicant requested that the commission attempt to regulate the price at which gas produced under its order is sold, the place of delivery to purchasers, and individual well connections," said the commission in its order.

"It is apparent that each of these factors is of considerable importance to drillers as well as to all other purchasers operating in the field. However, it is doubtful whether the commission should attempt, especially at this time, to claim or disclaim any control with respect to these particular considerations.

"Matters of this character have generally been left to the determination of the parties involved in accordance with customs and practices prevailing in the industry itself, and until there is more definite indication that the authority already delegated to the commission includes the right to affect commercial transactions directly, the commission should confine its orders to production control alone."

The commission also ordered that all overproduction by wells in the pool must be made up within 180 days or wells charged with excess production be shut-in until overages are made up.

●

Louisiana Adopts New Oil Reporting Forms

A new set of forms for reporting movement, refinement, and stocks of oil has been adopted by the Louisiana Conservation Commission. The new forms, which became effective January 1 and repeal and supersede all forms then effective, eliminate much unnecessary duplication of work and give a clearer picture of the state's statistical position as relates to oil.

These new forms are the work of a committee selected by the Mid-Continent Oil and Gas Association at the request of B. A. Hardey, conservation commissioner of Louisiana. The Department of Interior Tender Board of Kilgore, Texas, also assisted.

●

Favors California Joining Interstate Oil Compact

A recommendation that California become a member of the Interstate Oil Compact has been made by the board of directors of Oil Producers Agency of California. The recommendation, in the form of a resolution, was mailed to all members of the State Legislature, as well as to Governor Olson and to the director of natural resources, Richard Sachse.

"The Interstate Oil Compact, which has been in existence since 1935, consists of a group of oil producing states each of which has agreed to prevent physical waste in the production of oil," said L. L. Aubert, president of the Agency. "California, through its Natural Resources Code and its Division of Oil and Gas, which administers the Code, already has the requisite legislation on its statute books. For us to join the compact requires only the passage of an enabling act by the State Legislature. Members of the Interstate Compact are not bound by the action of the Interstate Compact Commission, which functions purely in an advisory capacity, nor is it necessary for member states to have laws controlling the production of oil. So far as California is concerned, the state can become a member of the compact with no further legislation, and can function as a full member-state under the voluntary conservation program now in effect here.

"The Agency Board is of the opinion that for California to join the compact will strengthen the oil industry's nationwide efforts to conserve oil. As a member, California will be entitled to take full part in the deliberations of the Compact Commission, which meets quarterly. At present, not being a member, California has been limited to the mere observance of action taken by the Commission, and has not been able to assist in the formulation of policy," Aubert said.

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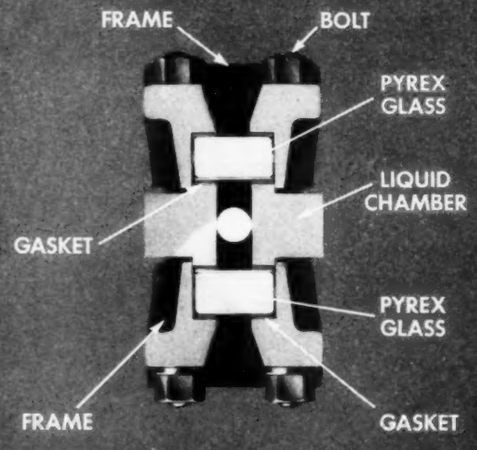

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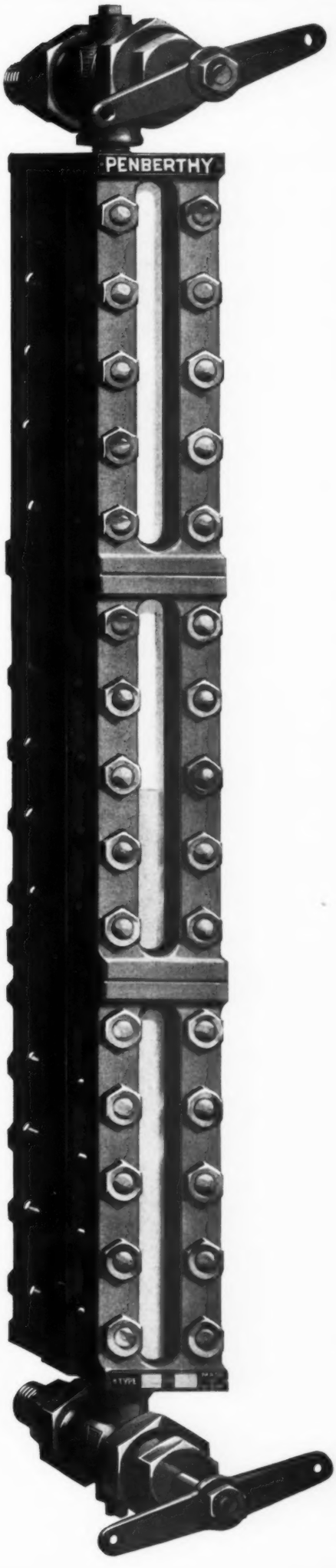

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Activities in the Oil Fields

NO. 1 J. L. MABERRY, well drilled by Stephenson and Long-Wolfe, in section 56-H & TB, near the town of McCaulley, Fisher County, Texas, recently flowed 57 bbl. of oil per hr. from the Swastika sand at depth of 3278-3302 ft. This discovery opens up a new field for West Central Texas.

●

A discovery well in Okfuskee County, Oklahoma, recently flowed at the rate of 54 bbl. per hr. from the Gilcrease sand. The well, No. 1 Dudgeon, drilled by Henry, Harvey et al is in NE SW SE 36-12-9.

●

Dimmit County, previously in the fast-diminishing list of counties in Texas not yet found productive of oil or gas, now has promise of a new field as a result of a test five miles from Carrizo Springs in G. W. T. & P. Survey 653. The well, No. 1 McKnight-Bennett, drilled by Producers Corporation of Nevada, logged gas at depths of 1699 to 1710 ft. and oil at 2294 to 2298 ft. Production is believed to be from the Navarro formation. This well extends the Balcones fault zone 50 miles southwest.

●

Southern Producing Company's No. 1 Gannon-Frost well in NE NE 12-11n-16w, DeSoto Parish, Louisiana, gauged 177,000,000 cu. ft. of wet gas per day following completion in the Glen Rose lime at a total depth of 4975 ft. This discovery may open an extensive gas field.

●

After speculation for nearly a year as to whether the Trenton limestone underlying the Salem-Lake Centralia field, Illinois, would ever prove productive, Rossi's No. 8 Brooks obtained substantial production from that formation, to revive drilling and deepening operations in this largest Illinois field.

No. 8 Brooks, in SW NE SW 29-2n-2e, Salem township, Marion County, flowed 15 bbl. per hr. during completion of the well in the Trenton at a total depth of 4609 ft. The well had been completed during 1940 in the Devonian lime—previously the deepest producing formation in the field.

All offset locations are controlled by The Texas Company and the Magnolia Petroleum Company.

●

East Texas' newest oil boom town is Hawkins, on the Dallas-Longview highway, a few miles west of Gladewater.

Following completion of No. 1 Cobb, drilled by Jackson and Rotundi in the townsite of Hawkins, events have moved rapidly. No. 1 Cobb gauged more than 100 bbl. per hr. on a 1-in. choke, with a gas-oil ratio of 800, and tubing and casing pressures of 290 and 640 lb. per sq. in., respectively, while flowing.

Soon after the discovery was made, Manziel No. 1 Lee Bell, a mile north of Hawkins blew out but is now under control.

Second townsite well, nearing completion, is Hollandsworth Drilling Company's No. 1 L. B. Robbins. A 5½-in. casing string was recently set, after an electric log that indicated 150 ft. of oil sand, said to be the Woodbine.

●

To be an innovation in drilling, Cosden Petroleum Company is drilling a well on its tank farm near its refinery east of Big Spring, Howard County, Texas, hoping to develop the high-pressure air-nitrogen zone at the 1460 ft. depth and utilize the air for power in the refinery.

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Wilmington	.60-1.14		
Montana	.80-1.10	Illinois	1.00-1.15
Wyoming	.35-1.30	Kentucky	1.05-1.20
Colorado	.90- .98	Indiana	1.00
New Mexico	.77-1.00		
Texas		Ohio	
North Central	.71-1.03	Lima	.90
Panhandle	.67- .96		
West Texas	.53- .95	Michigan	.81-1.22
Gulf Coast	.86-1.28		
Darst Creek	.96	Pennsylvania	
East Texas	1.10	Bradford	2.15
Talco	.65	Southwest	1.80
		Eureka	1.74
Kansas	.60-1.10	Buckeye	1.70
Oklahoma	.60-1.10	Corning	1.12
Arkansas	.73- .95	Canada	2.10-2.17

DAILY AVERAGE CRUDE OIL PRODUCTION

Data Supplied by A.P.I.

(Figures in bbl. of 42 gal. each)

	[1]B. of M. Calculated Requirements (January)	Week Ended Jan. 4, 1941	Week Ended Nov. 30, 1940	Week Ended Jan. 6, 1940
Oklahoma	439,000	[2]403,350	403,550	435,700
Kansas	191,000	[2]181,450	196,650	166,400
Nebraska	2,000	[2] 2,300	2,550	50
Panhandle Texas	.....	71,400	50,500	87,800
North Texas	.....	90,900	106,250	79,350
West Central Texas	.....	29,600	28,150	31,250
West Texas	.....	174,300	178,800	240,800
East Central Texas	.....	76,700	72,850	81,750
East Texas	.....	301,250	298,700	394,550
Southwest Texas	.....	164,000	159,800	203,350
Coastal Texas	.....	210,700	194,300	228,050
TOTAL TEXAS	1,297,500	1,118,850	1,089,350	1,346,900
North Louisiana	.....	68,950	66,500	66,750
Coastal Louisiana	.....	224,200	219,850	202,300
TOTAL LA.	287,400	293,150	286,350	269,050
Arkansas	66,100	69,150	69,400	69,450
Mississippi	15,200	[2] 14,900	16,000	2,450
Illinois	340,300	330,550	327,400	330,050
Indiana	20,000	[2] 19,750	20,550	99,400
Eastern (not incl. Ill. and Ind.)	94,800	95,450	89,250	
Michigan	46,100	41,850	46,350	68,150
Wyoming	73,900	76,650	72,650	64,650
Montana	19,000	18,150	17,800	16,950
Colorado	3,900	3,550	3,500	4,150
New Mexico	100,000	101,400	101,100	109,100
TOTAL EAST OF CALIF.	2,996,200	2,770,500	2,742,450	2,982,450
California	594,800	596,700	592,600	602,000
TOTAL U. S.	3,591,000	3,367,200	3,335,050	3,584,450

[1]These are U. S. Bureau of Mines' calculations of the requirements of domestic crude oil based upon certain premises outlined in its detailed forecast for the month of January. As requirements may be supplied either from stocks, or from new production, contemplated withdrawals from crude oil inventories must be deducted from the Bureau's estimated requirements to determine the amount of new crude to be produced.

[2]Oklahoma, Kansas, Nebraska, Mississippi, and Indiana figures are for week ended 7 A. M., January 1.

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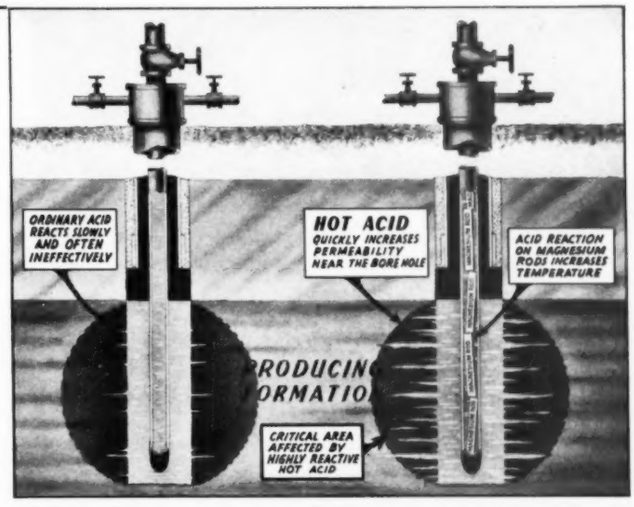
Remarkable Results Being Secured with New Treatment and Technique . . . Developed by Dowell Incorporated

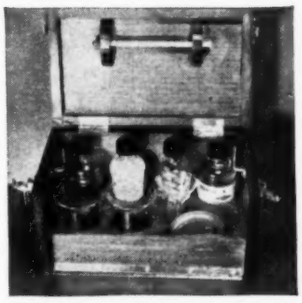
● Case histories that read like fiction!... "A" reports increase from 65 to 232 barrels per day; "B" from 1 to 5 barrels per day; "C" from 1½ to 10 barrels; "D" from 21 barrels to 44; "E" from 850 barrels to 1700; "F" from 3 barrels of oil and 100 water per day to 21 barrels of oil and 100 water. This revolutionary HOT ACID treatment has produced remarkable results where response from conventional treatments has been negligible. Here's truly a most astounding contribution to the industry.

This new development by Dowell makes it possible to introduce HOT ACID at controlled temperatures directly into the formation. The treatment is made by placing magnesium rod in the tubing at the bottom of the well and then pumping acid into the tubing.

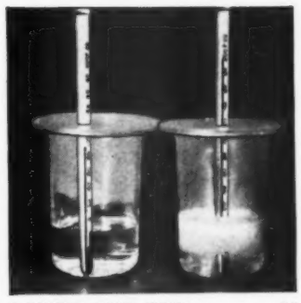
The reaction between the magnesium rod and hydrochloric acid generates a tremendous amount of heat, thereby increasing the effectiveness of the treating solution. The actual temperature to which the acid is heated is regulated by the amount of magnesium, the quantity of acid used and the pumping rate. To prevent metal well equipment from being attacked by this increased effectiveness of HOT ACID, carefully chosen Inhibitors are used.

HOT ACID treatments are recommended for wells having slowly soluble formations or paraffin scale clogged screens and clogged perforations. The treatment is especially effective: (1) For dolomitic areas; (2) Where immediate action is needed near the bore hole; (3) For reverse compound treatments; (4) For soluble scale deposits on formations, screens and perforations; (5) For mixed paraffin-scale screen and perforation cleaning. DOWELL INCORPORATED, Executive Office: Midland, Michigan; General Office: KENNEDY BLDG., TULSA, OKLAHOMA; Subsidiary of The Dow Chemical Company.


ORDINARY ACID REACTS SLOWLY AND OFTEN INEFFECTIVELY
HOT ACID
QUICKLY INCREASES PERMEABILITY NEAR THE BORE HOLE
ACID REACTION ON MAGNESIUM RODS INCREASES TEMPERATURE
CRITICAL AREA AFFECTED BY HIGHLY REACTIVE HOT ACID

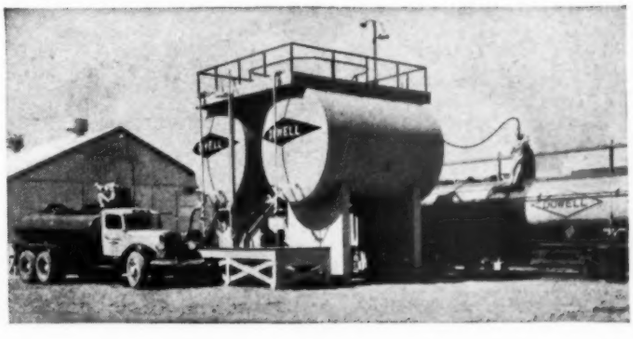


With kits like this one Dowell treaters test the reaction of both HOT and COLD ACID on samples of the formation to be treated. Preliminary tests of this kind eliminate guesswork and establish applicability of the new HOT ACID treatment.



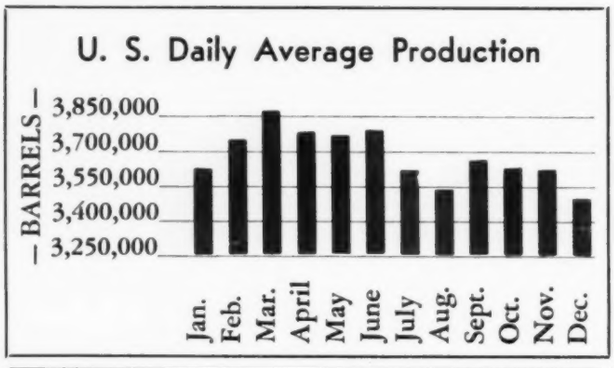
DOWELL HOT ACID versus cold acid, acting on Permian dolomite (West Texas). Fast reaction occurs in the beaker on right with acid at 195° F., while cold acid in the beaker on left, temperature 98° F., reacts slowly and ineffectively.

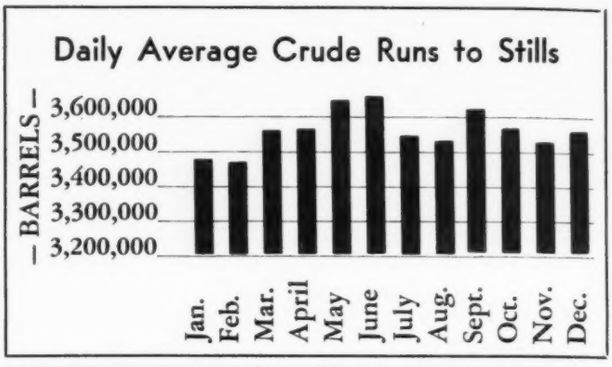
Look to
DOWELL
FOR OIL AND GAS WELL CHEMICAL SERVICE

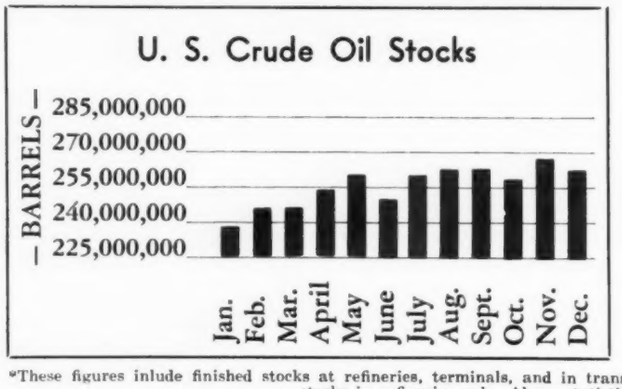


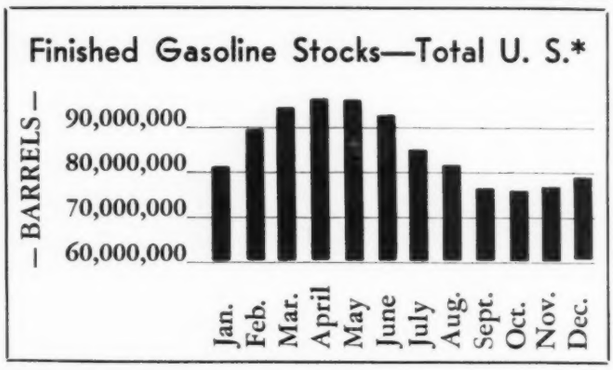
Typical Dowell treating station. 28 such stations are equipped to provide the new Dowell HOT ACID service. ➔

Petroleum Statistics and Field Activities









*These figures inlude finished stocks at refineries, terminals, and in transportation in pipe lines. Previous to June, 1939, this chart showed finished stocks in refineries only. Above statistics by the American Petroleum Institute.

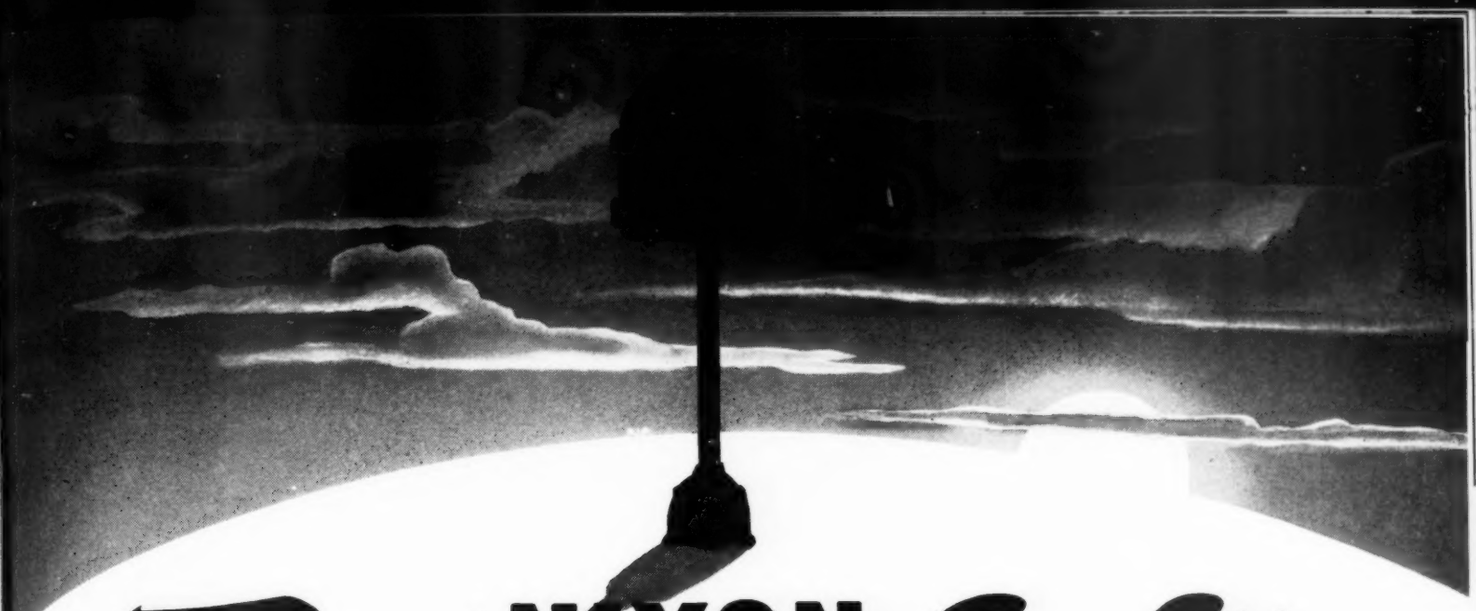
Summarized Operations in Active Fields for December, 1940

Fields	Completions	Producers	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
TEXAS								
East Texas	39	38	6	20	3500-3700	2	40	Rotary
Duvall County	32	17	5	15	1554-2900	2	22	Rotary
Ector County	25	25	15	43	3675-4377	2 and 3	32-36	Rot.-Cab.
Panhandle	33	30	11	47	1700-3900	2	40	Rotary
Refugio County	5	5	2	4	4900-5900	2	38	Rotary
Nueces County	17	14	3	6	3922-5878	2 or 3	21-54	Rotary
K. M. A. Field	26	26	8	53	3730-3935	2	42-43	Rot.-Cab.
OKLAHOMA								
Fitts Pool	14	9	2	5	1800-4488	2 or 3	38	Rotary
KANSAS								
Russell County	21	18	4	11	2926-3435	2 and 5	32-37	Rot.-Cab.
Rice County	12	9	6	14	3222-4085	2 and 5	42-48	Rot.-Cab.
Barton County	24	23	8	22	3290-3518	2	39-42	Rot.-Cab.
ILLINOIS								
Central Illinois	275	193	261	100	1425-4100	2	36-38	Rot.-Cab.
NEW MEXICO								
Lea County	26	22	13	44	3150-4030	3	30-34	Rot.-Cab.
CALIFORNIA								
Kettleman Hills	2	2	1	9	8300-8730	3 or 4	40	Rotary
Wilmington	10	10	12	11	3500-4000	2 and 3	18-20	Rotary

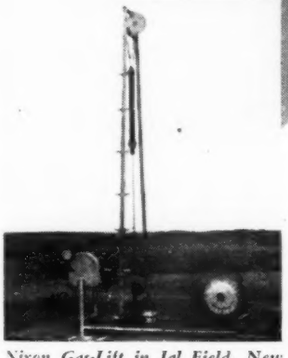
Field Activities by States for December, 1940

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1939 (In Barrels)
	December	November	December	November	December	November	December	November	December	November	
Arkansas	12	13	9	10	14	11	2	4	30	29	21,266,994
California	90	87	81	79	80	68	74	83	180	176	224,336,682
Colorado	2	2	0	0	....	....	2	2	35	30	1,402,599
Illinois	275	328	193	245	336	340	261	258	100	97	92,915,620
Indiana	66	65	42	39	....	....	5	12	69	75	1,426,000
Kansas	186	185	152	148	161	158	32	30	176	220	59,952,340
Kentucky	43	42	24	23	....	....	12	9	98	85	5,611,500
Louisiana	154	156	113	108	100	142	25	28	205	204	94,110,736
Michigan	90	91	42	40	60	70	34	29	129	137	23,185,203
Mississippi	20	22	14	16	....	....	4	6	30	34	102,918
Montana	21	20	20	20	....	....	5	8	68	66	5,901,058
Nebraska	12	11	10	9	10	15	5	6	30	24	....
New Mexico	40	41	32	33	29	38	18	20	99	103	37,453,117
New York	70*	71*	70*	70*	....	....	10	12	60	62	5,105,000
Ohio	145	159	115	127	....	....	53	52	176	180	3,157,500
Oklahoma	195	200	150	153	164	190	35	39	231	266	156,421,939
Pennsylvania	146*	124*	140*	107*	....	....	....	....	....	....	17,342,500
Texas	749	743	574	570	912	726	349	350	1032	1056	485,847,999
West Virginia	69	70	52	54	....	....	20	23	148	151	3,556,500
Wyoming	11	10	10	9	....	....	9	10	67	69	21,408,478
Total	2396	2440	1843	1860	1866	1751	955	981	2963	3064	1,260,504,683

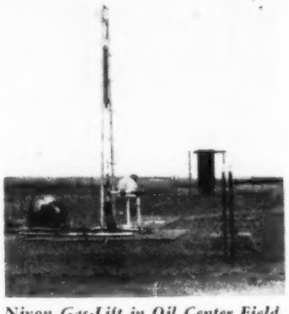
*Includes water-intake and pressure wells.



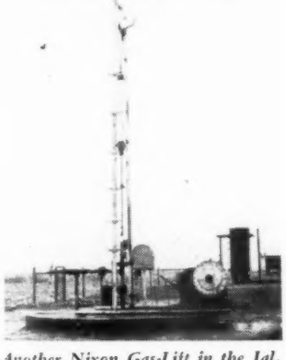
Typical NIXON Gas-Lift INSTALLATIONS



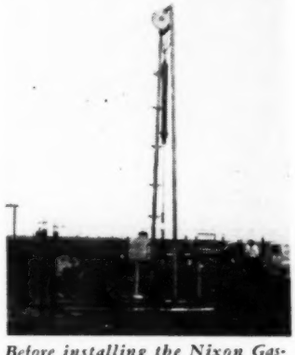
Nixon Gas-Lift in Jal Field, New Mexico. Prior to the Nixon installation, this well made 13 bbls. oil and 3 bbls. water. It is now making 38 bbls. oil and only 5 bbls. of water. Operating depth, 3950 feet.



Nixon Gas-Lift in Oil Center Field, New Mexico. This well was dead before the Nixon Gas-Lift was installed. It is now making 130 bbls. of oil on a gas fluid input ratio of 430 to 1. Operating depth, 3925 feet.



Another Nixon Gas-Lift in the Jal, New Mexico Field. After the Nixon installation, production increased from 50 bbls. of oil to 118 bbls. This well has a gas fluid input ratio of 382 to 1.



Before installing the Nixon Gas-Lift, this well in Monument Field, New Mexico, was making 16 bbls. of oil and 2 bbls. of water. It is now making 35 bbls. of oil and 4 bbls. of water.

CASE HISTORIES of these installations, illustrate the economy and efficiency with which the Nixon Surface Control Gas-Lift System lifts fluid. They are random examples from the many hundreds of installations now in operation.

The Nixon Surface Control Gas-Lift is made in the largest and most modern plant devoted exclusively to the manufacture of Gas-Lift Equipment.

The original cost of a Nixon Surface Control Gas-Lift installation is far below that of any standard pumping unit. The results (lowest cost fluid lifting; lowest cost, maintenance and upkeep) obtained with the Nixon Gas-Lift are beyond conception if you haven't actually produced wells by this modern method. The original installation will deplete a well without adding or changing equipment. The Nixon Gas-Lift will operate in all wells. lift any volume from any depth.

Have a Nixon Gas-Lift engineer tell you what this equipment is doing for others. Write your nearest Wilson Supply Company store or sales office.

WILSON SUPPLY CO.

1412 MAURY ST.

EXCLUSIVE GULF COAST DISTRIBUTORS FOR:
Wilson-Snyder Pumps; American Cable Tru-Lay Preformed Wire Rope; Kewanee Boilers; Drift Meter, Jr.; Gray Swivel; Nixon Surface Control Gas Lift; Nixon True-Taper Slip and Spider; Bowen Pack-Off and Releasing Drill Pipe Overshot; Douglas Weight Indicator; Coffey Robot Stack Draft.

OIL & GAS WELL SUPPLIES

Complete line of Fishing Tools and Service

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BRANCH STORES:
TEXAS: Gladewater; Barbers Hill; Bay City; Monahans; Alice; Victoria, Corpus Christi.
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TRINIDAD B. W. I.: Neal Massey Eng. Corp.

Major Pipe Line Activities

CONSUMERS POWER COMPANY, which has under construction 22 miles of 12¾-in. natural gas line, has been granted a permit by the Michigan Public Service Commission to extend the line another 38 miles in the spring.

The 22-mile section being laid extends from the Wise gas field, Isabella County, southeast to connect with the company's 8-in. line from Six Lakes to Bay City. The 38 miles will extend from the Wise field terminal to the new fields in Missaukee, Osceola, and Clare Counties, discovered by Taggart Brothers. The fields, which consist of 7000 acres, have been only partly developed.

●

W. R. Davis and Company have received bids for construction of a 120-mile, 8-in. oil pipe line to extend from the Rincon field, Starr County, Texas, to Brownsville. It is estimated the cost will approximate $1,000,000.

A primary pumping station will be erected in the Rincon field, capable of pumping 15,000 bbl. of oil per day. This line capacity can be increased to 24,000 bbl. per day when conditions warrant by the addition of an intermediate pumping station.

A $2,000,000 refinery is to be built at Brownsville at a later date to process crude oil from the Rincon and other fields in the western part of the Rio Grande Valley. At the present time there is only one pipe line in the area, the one operated by the Valley Pipe Line Company, which extends from the Sam Fordyce field to Port Isabel, with a lateral to W. R. Davis and Company's tank farm at Brownsville.

●

West Texas Gas Company, Lubbock, is laying a 14-mile, 6-in. gas line from the North Cowden field to tie-in with its existing system at Odessa. The new gas supply will supplement that now received from the Texas Panhandle area. A contract has been entered into whereby the West Texas Gas Company will purchase residue gas from Cities Service Oil Company's natural gasoline plant in the North Cowden area.

●

The B. and M. Construction Company, of Oklahoma City, Oklahoma, is laying 16 miles of 6-in. oil pipe line for the Pure Oil Company from the Cumberland field, Oklahoma, to connect with The Texas-Empire Pipe Line Company's system at the Armstrong station north of Durant. The line originates at Pure's tank farm in the west edge of the field. The crude oil will be transported to Pure's South Bluffs refinery near Beaumont, Texas.

●

Gladewater Refining Company is completing plans for construction of a 14-mile pipe line from the recently discovered field at Hawkins, Wood County, Texas, to the company's refinery at Gladewater. The Humble Oil and Refining Company, which owns 13,000 acres in the area, has also announced it will extend its line to the field and will purchase crude oil at a price of 78 cents a barrel. At the present time, Humble is accepting truck deliveries from the field at Longview station, paying 78 cents plus 5 cents, a total of 83 cents per barrel.

A new line to deliver crude oil to the White Eagle Refinery at Augusta, Kansas, from the Roxbury pool, McPherson County, will be constructed by Socony-Vacuum Oil Company, Inc., from the field to its Ritz-Canton pump station. The 4-in. line will be 12 miles long. Bay Petroleum Company is now operating a line from the Roxbury pool to its refinery at McPherson, Kansas.

●

H. C. Price Company of Bartlesville, Oklahoma, has been awarded the contracts for electric welding on the following pipe lines:

For Southern Natural Gas Company, 10 miles of 8-in. and 14 miles of 12-in. near Selma, Alabama. General contractor is B. & M. Construction Corporation. This work has recently been completed.

For Consumers Power Company, 22 miles of 12¾-in. running northwest from Midland, Michigan. General contractor is J. C. Dowding.

For Kaw Pipe Line Company, 22 miles of 8-in. from Gorham, Kansas, to Bemis Pool. General contractor is Fredell Construction Company.

●

Erection of the new explosives plant by the United States government near Wilmington, Illinois, necessitates the rerouting of three major trunk pipe lines crossing the reservation assigned to the new plant. Of the three companies owning these lines, the Sinclair Refining Company, The Texas-Empire Pipe Line Company, and Stanolind Pipe Line Company, only the latter, having the greater mileage involved, has taken steps to re-lay its lines. The other companies plan to undertake the necessary work later in the year.

Sheehan Pipe Line Construction Company has the contract for taking up and relaying the three lines, each 15 miles in length, owned by Stanolind. One of these is an 8-in. and two are 12-in.

●

Nearing completion is the construction of 165 miles of 12-in. crude oil pipe line between LaPlata, Missouri, and Wood River, Illinois. Being built for Stanolind Pipe Line Company by Texokan Company (Jones and Brooks) and O. C. Whitaker Company, the line will transport crude oil from the Mid-Continent and Rocky Mountain areas.

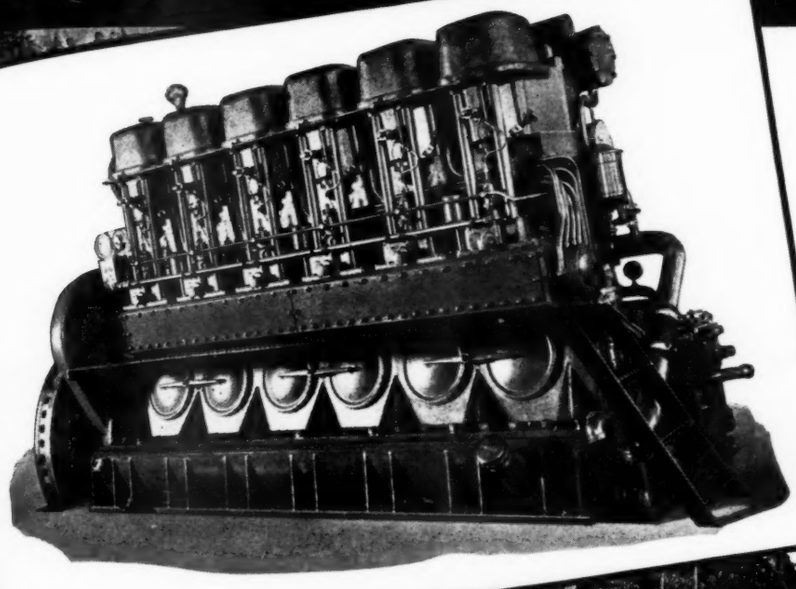
●

Lone Star Gasoline Company, Dallas, Texas, is now operating the recently completed 48 miles of 8-in. line from San Angelo, Texas, to Schleicher County's Page field. Beginning in May, the line will be used to transport natural gas to utilities situated at San Angelo.

●

Finishing touches are being made in the construction of Pan-American Pipe Line Company's 8-, 10-, and 12-in. crude oil pipe line from East Texas to the Gulf Coast. The 260-mile line was built by Williams Brothers Corporation, Tulsa, Oklahoma.

DE LA VERGNE



PIONEER DIESEL IN PIPE LINE PUMPING SERVICE

First oil engine in the petroleum industry — a *De La Vergne in 1905.*

First oil engine in trunk pipe line service — a *De La Vergne in 1907.*

Engine illustrated, a 6-cylinder Model VO for pipe line pumping service.

THE BALDWIN GROUP

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PHILADELPHIA

Activities in Refining

Percent Refining Capacity Operated

Western Division, 55.8 Percent **Central Division, 80.0 Percent** **Eastern Division, 88.5 Percent**

PHILLIPS PETROLEUM COMPANY has under construction at its Borger, Texas, refinery, the first butadiene plant for the Mid-Continent area. It is expected to be completed and placed in operation the early part of this year.

The plant will recover the butadiene, which is now made incidentally in the manufacture of neohexane. The butadiene will be utilized in the manufacture of synthetic rubber by the Hydrocarbon Chemical and Rubber Company, Akron, Ohio, which handles the synthetic rubber interests of the B. F. Goodrich Company and Phillips Petroleum Company.

Ross W. Thomas, of the Philgas Division of Phillips, is president of the new concern, and Dr. Waldo L. Semon of Goodrich, one of America's outstanding research scientists, is vice-president and director of research.

●

The cracking plant near Odessa, Texas, owned and operated by Cities Service Oil Company, is being enlarged by addition of gas purification and dehydrating equipment. Cost of the improvements is approximately $175,000.

●

Geier Brothers, Inc., and F. B. Jackson, of Dallas, Texas, have formed a partnership and announced plans for the construction in the Grapeland, Texas, area of a recycling plant having a daily capacity of 53,000,000 cu. ft. John L. Hill, formerly with the Continental Oil Company, has been employed by the company as chief engineer.

The contract for construction of the plant has been let to Hudson Engineering Company, of Houston, Texas.

The partnership recently obtained about 3000 acres in the Grapeland area on farmouts from several companies and already has a drilling program under way that calls for the completion of 8 wells in the Woodbine, which is at an approximate depth of 6000 ft. The operators also have purchased from J. C. Cook et al. their 83-acre Masters-Shell lease on which one well has been completed.

●

Construction has begun on the $12,000,000 toluol plant at the Baytown, Texas, refinery plant of the Humble Oil and Refining Company. The first building, now being erected, will cost about $200,000. Other preliminary work will involve an expenditure of about $150,000. A barracks for 300 workers also will be built.

●

Forerunner in a trend that may become increasingly important, even in this country, is the proposed construction of an underground refinery "somewhere" in England. The plant, to have complete processing facilities, will produce 30,000 gal. of petroleum products per day, of which a substantial part will be fighting grade gasoline for airplanes.

●

The first barrel of toluene from America's first petroleum toluene refinery was taken off recently, more than a month ahead of schedule, R. H. Waser, manager of the Shell Oil Company's Houston, Texas, plant, has announced.

Construction began only four months ago and continued night and day at the greatest possible speed. The refinery was originally expected to start large scale production of high quality toluene during the middle of January. The new process will help prevent recurrence of the serious bottleneck caused during the World War by limited facilities for recovering toluene from coal tar. The plant at Houston will produce more than 2,000,000 gal. annually, from which it is possible to produce about 20,000,000 lb. of TNT. In addition to the present method, which is an extractive rather than a synthetic process, Shell has perfected a second process under which petroleum molecules are rearranged to give toluene. By utilizing the second process as a supplement to the first, the output of the Houston refinery can be increased to 10,000,000 gal. of toluene per year, if necessary, from which an annual total of 100,000,000 lb. of TNT may be produced. If needed, Shell's refineries in other sections of the U. S. could increase this output considerably — possibly to as much as 40,000,000 gallons.

Besides wartime requirements, a growing list of peacetime uses for toluene is being found. At the present time, the greatest industrial demand for the product is in the paint and lacquer industry, where it is used as a thinner. Other important uses are in the manufacture of dyestuffs, as an ingredient of aviation gasoline, and in blasting and other operations where an explosive is needed.

Crude Runs to Stills, Gasoline, Gas and Fuel Oil Stocks
Week Ended January 4, 1941
A.P.I. Figures
(Figures in thousands of bbl. of 42 gal. each)

DISTRICT	Percent Potential Capacity Reporting	Daily Average Crude Runs to Stills	Percent Operated of Total Capacity Reporting	Total Motor Fuel Stocks	Total Gas and Fuel Oil Stocks
East Coast	100.0	583	90.7	18,193	26,446
Appalachian	91.0	116	81.7	3,204	861
Ind., Ill., Ky.	90.2	624	93.1	15,112	7,460
Okla., Kans., Mo.	76.9	262	81.1	7,327	3,504
Inland Texas	59.6	111	66.5	1,916	2,104
Texas Gulf	89.2	901	94.3	12,972	15,516
La. Gulf	97.6	111	69.4	2,697	3,713
No. La. and Ark.	51.5	46	88.5	509	758
Rocky Mt.	56.0	32	47.1	1,104	587
California	87.3	471	64.5	15,869	81,377
Reported	86.2	3,257	83.3	78,903	142,326
Estimated Unreported		343		6,150	2,525
*EST'D TOTAL U. S. JAN. 4, 1941		3,600		85,053	144,851
*EST'D TOTAL U. S. DEC. 28, 1940		3,585		83,274	144,886
U. S. B. of M. *JAN. 4, 1940		**3,427		83,911	138,021

*Estimated U. S. Bureau of Mines' basis.
**January, 1940, daily average.

P 422.912

THE Petroleum Engineer

JANUARY, 1941

PETROLEUM ENGINEER EXCLUSIVE FEATURE

Suggestions For Improving Design of Marine Drilling Barges

Unitized craft is proposed, combining drilling and boiler facilities in one large barge

By G. I. McBRIDE

Geologist and Engineer, Buttes Oilfields, Inc., Yuba City, California

A RECENT article on marine drilling[1] stressed the increasing costs of a complete drilling barge set-up. It is quite true that it is now possible to spend a quarter of a million dollars for one drilling assembly. Some of these barges, in the last five years, have become quite elaborate and complete in detail. The writer has watched the development of drilling barges until in some cases, in the writer's opinion, it would seem that the designers have lost their sense of proportion, particularly from the investment viewpoint. Recently received on fair authority is an estimate of $65,000 for a drilling barge and $15,000 for a boiler barge. Against this $80,000 investment, the writer suggests a combined drilling and boiler barge for $30,000.

In the article referred to, it is suggested that the drilling barge be eliminated, saving the $15,000 royalty, and that a pile-driven drilling structure be employed that may be used later as a foundation for a pumping unit. The writer cannot quite agree with this thought. The ease with which a drilling barge may be moved represents a distinct economic advancement that should not be idly discarded.

In every major oil company's accounting files are to be found certain records that should be of great value to the engineer interested in the subject of barge design from the investment standpoint. These are the auditor's close-outs on expenditures for *each* new well, and in them will be found items that are seemingly small: derrick hatchets, nuts, bolts, pipe dies, valves, lights, wire, welding rods, concrete, lumber, tools, etc. Having examined the auditor's close-out on numerous wells, the writer indicated the figure of $5,000 in a former article[2] as representing the average "losses" exclusive of labor, incurred in tearing down and rigging up for a relatively deep Gulf Coast well.

Let us examine this problem from the beginning. Several years ago, Ed LeGuerre, operating in Lake Washington, Louisiana, had the idea he could build a floating-type drilling barge. He discussed this with many reputable engineers who advised him it couldn't be done. So he did it. And whimsically named it the "Impossible." For the more southerly locations, affected by tide and wind, the writer had the inspiration that a submerged barge would afford the only answer. And at the present time we wonder: "Why would not a large floating barge be even bet-

G. I. McBRIDE

received a B.S. degree in geology from the University of California, 1926—Upon graduation did geological work for Associated Oil Company, roughnecking and wellpulling for General Petroleum Corporation, was inspector for the California Mining Bureau, Division of Oil and Gas, then petroleum engineer for The Texas Company—The latter company transferred him to Louisiana in 1929, where he became chief engineer for Louisiana, Arkansas, and East Texas until the fall of 1936—Followed a period of varied work in the Mid-Continent area—The last two years he has been engineer and geologist for The Buttes Oilfields, Inc.

[1] "Drilling-Rig Layout for Water Locations in the Gulf Coast," by I. W. Alcorn, *The Petroleum Engineer*, April, 1940.

[2] "Drilling Barges," by G. I. McBride. Paper presented before meeting of A.P.I., Southwest District, Division of Production, San Antonio, Texas, April, 1935.

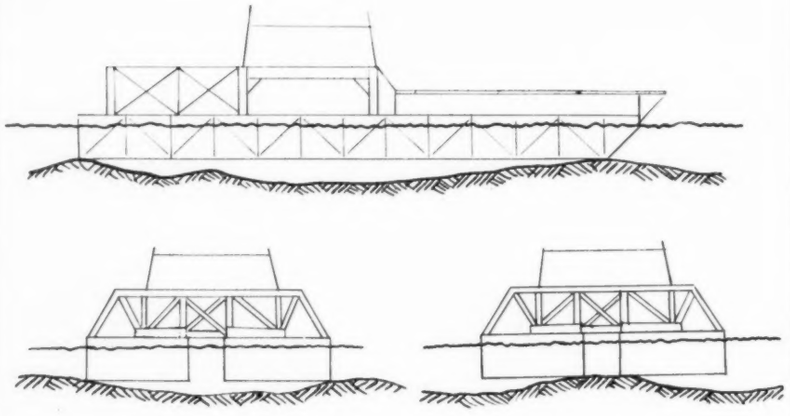


Fig. 1. Illustrating types of uneven bearing encountered by submersible barges

ter, faster, and cheaper than a sinking type?"

The original submersible barges were designed to settle on an uneven lake bed, as shown in Fig. 1. In some instances there might be sand bars at either edge or end; in others there might be one sand bar disposed centrally. The trusses joining the barges, and the hulls themselves, were designed to withstand the severe stresses created by such conditions. Experience has shown that unequal bearing does not now seem so important; every builder of a barge rig has observed that the unit, before being sunk, had an unusual stability.

Nowhere can be found a better equalizer of pressure than a body of water. In Fig. 2 is shown a pair of barges of light construction, and a superstructure weighing much less than similar elements in previous drilling barge design. The barges are purposely shallow, in that the closer the center of mass is brought to the water line the more stable becomes the unit. Calculations indicate that a 40 m.p.h. wind would tilt the derrick only 2¼ in. from vertical, and operations are usually suspended during winds in excess of 40 m.p.h.

Gulf Coast marine drilling operations may be grouped generally under one of these classifications: (1) a wildcat, having no previously developed fuel available and (2) a proved canal or lake development. The greater number of wells drilled are of the latter type.

If the well is drilled under contract, as so many wildcats are, the contractor usually has the responsibility of providing the drilling equipment. But when the choice of drilling equipment is to be made by the oil company, as in developing a proved field, it is recommended that the following points be considered:

1. A direct-driven Diesel rig contributes to economical operation, but for deep wells has limitations.

2. A steam turbo-electric d-c. power plant, having the flexibility of steam, is initially expensive but particularly adaptable to marine work.

3. The Diesel-electric plant is less expensive and more economical than the turbo-electric, offers close competition, but is somewhat less flexible.

Of these choices, the writer prefers the steam turbo-electric for its adaptability and rugged out-and-out dependability. Only a few years ago the industry was timorous of using d-c. power for drilling—it hadn't been "proved," notwithstanding the fact that, long before then, seamless tube mills were employing d-c. motors to roll and pierce the red hot billets—severe service in which occasionally a cool billet would appear and the single d-c. motor driving the rolls would be required to deliver much of its 5000-hp. capacity to put the billet through.

Again, in comparing the Diesel-electric with the turbo-electric plant, the success, two years ago, of a steam-turbo-electric locomotive, led one of the major railroads to build two additional units.

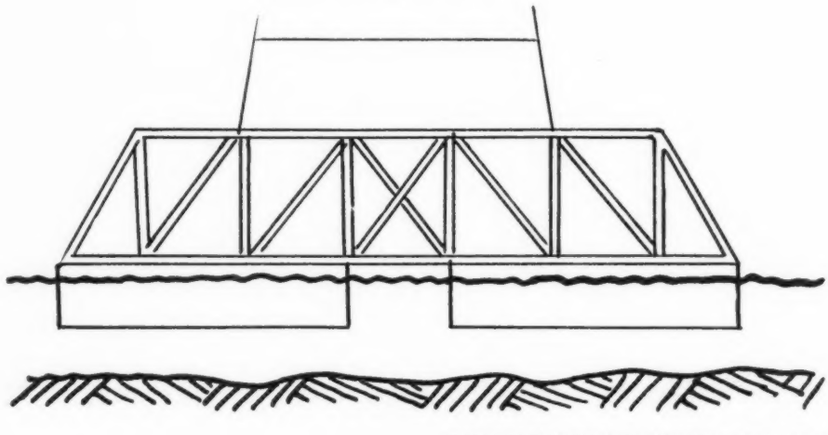
The application of electricity to well drilling is frequently considered as resulting in an insufficiently powered rig. If your requirements are less than 1200 or 1300 hp. don't read any further. But if they are, and if your wells are deep, and if they are in the Gulf Coast, and if you have to dig canals to get to them, why, read on!

It perhaps will be conceded that the major companies ventured into and made a success of Coastal drilling. As an independent engineer, the writer does not think their success has been carried on to completion.

The late Captain Marshall (Pennsylvania Shipyards, Beaumont, Texas) and the writer had many interesting talks contrasting marine vs. oilfield practice on lubrication of machinery and related matters. In these conversations it was disclosed that a 10,000-ton freighter with its quadruple expanding engine, the winches, hoists, bilge pumps, etc., may consume less than 5 gal. of cylinder oil on a *round trip* between Port Arthur, Texas, and England, as against some 300 bbl. on a drilling rig for equivalent output. There is not time, at the moment, to develop the reasons for one operation requiring 2400 times as much lubrication as a similar operation. But, having to drill in the Gulf Coast, where there is no boiler water, why can a proper boiler plant not be built?

Obviously, such a plant would be

Fig. 2. The character of the lake bottom may be disregarded when a floating barge is used



one that would distill, condense, and save all its water, one that would need not more than 2 percent make-up. There is only one way to obtain this, and that is by means of the turbine plant. The writer recognizes that the Diesel will show substantial economies over the latter, but where fuel is not a great concern, and where maintenance and dependability are of great importance the turbo-electric plant is, in the writer's opinion, the ideal solution for Coastal power. There is the emergency item that 400-lb. steam is available for special cleaning jobs and for auxiliary operations in event of power failure. It would cost little to provide steam power for the standby drawworks and to have second-hand, steam-driven high-pressure mud pumps available for emergencies.

The barges. Although it is true that portability is a desirable feature in a drilling barge, it is likewise true that a drilling barge may remain in one field for many years and be only rarely dismantled. To accommodate its movement within the field, canals of proper width are dug; hence, one may say, that once rigged-up, the barge will remain intact. Such being the common practice the writer shows in Fig. 3 a drilling barge and boiler barge, combined, composed of two shallow hulls, unified, and of inexpensive design. Inasmuch as the barge will float there is no need to protect the deck-mounted pump compartment. The shallow draft increases the stability, whereas the enormous increase in buoyancy with respect to weight indicates that canals of 5-ft. depth would be ample (buoyancy equals 545,000 lb. per ft. of draft).

In the perspective sketch, Fig. 3, it will be noted how all steel used is made to serve a purpose. There is no need of a centerline bulkhead. Two effective plate girders are developed by stiffening the inner sides of each barge and mud tank, and then extending these sides a short distance to connect with the two transverse trusses.

An ordinary locomotive type boiler barge fully equipped with four boilers, and nominally rated at 520 hp., costs $60,000. It must be moved separately when the drilling barge is moved. It must be disconnected and then reconnected, a walk must be driven, it is usually sunk and then floated again. In Fig. 3 is shown a drilling barge with the power plant integral. This design is a "natural" for California-type pipe racking, but may be rigged-up to accommodate the Mid-Continent method. The writer is not willing to concede that either method has particular advantage over the other.

Fig. 3 shows two barges, each 28 ft. in width, assembled so the entire unit measures overall 66 ft. by 160 ft. by 6 ft. deep, which provides a distance of 125 ft. between well and boilers. This in effect could be increased to 140 ft. by further removing stack and draft, but greater distance than this would require lengthened hulls.

Barges as simple as the above, weighing roughly 600,000 lb. including the two transverse trusses, mud and water tanks, fuel tank and pipe racks, one should be able to purchase for approximately 5 cents a pound, or $30,000 painted and delivered.

Equipment. Before itemizing the cost of the turbo-electric plant, consider what a modern rig of the so-called heavy type would cost mounted on the above barge. (Note: Quotations are approximate only, but in the main will follow the leading manufacturers.)

Drilling Equipment:

48-in., 6-sheave 350-ton crown block	$ 3,100	
48-in., 5-sheave 300-ton traveling block	4,300	
300-ton connector	1,500	
250-ton swivel	2,700	
5¼-in. by 51-ft. octagonal kelly	1,700	
2-shaft, 3-speed, 10½-in. drumshaft drawworks including disengaging hydromatic coupling and 40-in. double hydromatic brake	27,500	
High-speed rotary, 20½-in. opening	4,500	
3000 ft. of 1¼-in. casing line	1,600	
3-in. by 50-ft. rotary hose	600	
Elevators and tongs	5,000	
15 by 8½ by 20 mud pumps, 350-hp., 2500-lb. fluid end	8,000	
14 by 14 drilling engine	6,300	
		$ 66,800

Boilers, derrick, etc.

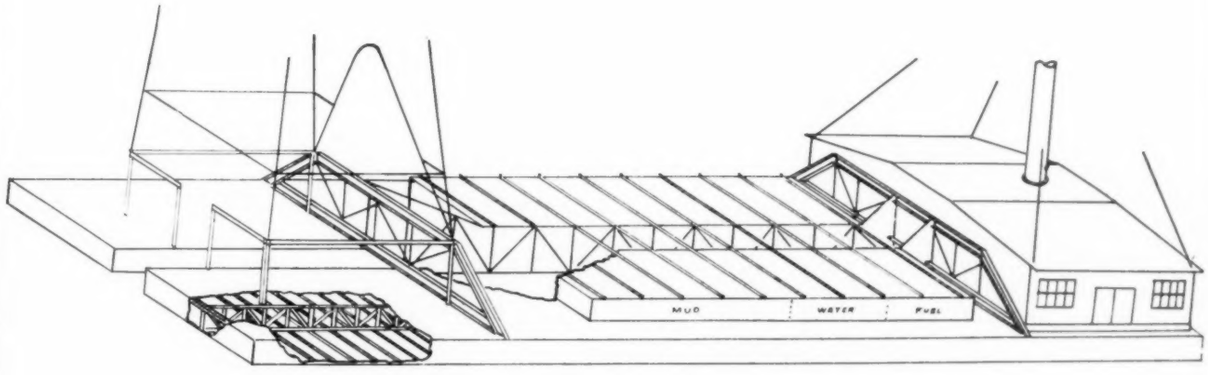
Four 130-hp., 350-lb. boilers with burners, superheaters, and three 10 by 5 by 10 feed pumps	29,000	
136 by 30 ft. base, 800,000 lb. capacity derrick with substructure adaptable to barge	6,000	
Weight indicator	750	
Two mud screens with turbines	2,400	
Grease extractor, condenser, and circulating pump	2,300	
23 by 60 ft. boiler house	1,500	
Miscellaneous tools and supplies	7,500	
Barges	30,000	
Labor	5,000	
		84,450
Total		$151,250

The above represents the minimum cost for a rig for deep Coastal drilling. It will be noted that an underfloor table drive, a standby drawworks, and drill pipe have not been included. Here the operator's choice and utilization of used equipment make it wise to leave these items open.

Although the above is comparable to most heavy rigs it does not represent the writer's preference; it was assembled as a comparison with present barges.

A. H. Bell (Continental Oil Company, Los Angeles) has granted permission to reproduce the drawing (Fig. 4) showing steps taken by his com-

Fig. 3. Unified barge combining the usual drilling and boiler barges



pany to avoid using the locomotive type boiler.[3] It will be noted there is an evaporator to supply make-up water and that an independent source of water must be provided for the cooling towers for steam condensation. In the Gulf Coast the cooling water is available to all rigs and without cost. On a drilling barge the time, cost, and labor of laying and removing the many lines indicated on A. H. Bell's drawing is enormously reduced.

Let the technician observe that with the multiplicity of lavishly lubricated reciprocating steam ends the Continental engineers have wisely provided for evaporator capacity of approximately 10 percent of the total throughput, or about 100 hp. to compensate for boiler feedwater losses. In the Coastal plant to be described the writer suggests an evaporator of not more than 1000 lb. per hr. capacity, which, roughly, would consume not more than 25 hp.

Let us examine the approximate cost of a Coastal marine drilling rig.

Boilers. We are in receipt of an approximate quotation from a Dallas, Texas, concern of the cost of two marine-type water-tube boilers, rated at 1750 hp. (maximum) including induced-draft fan and drive, superheaters, combination oil and gas burners, freight to Beaumont, Texas, and all erection charges.

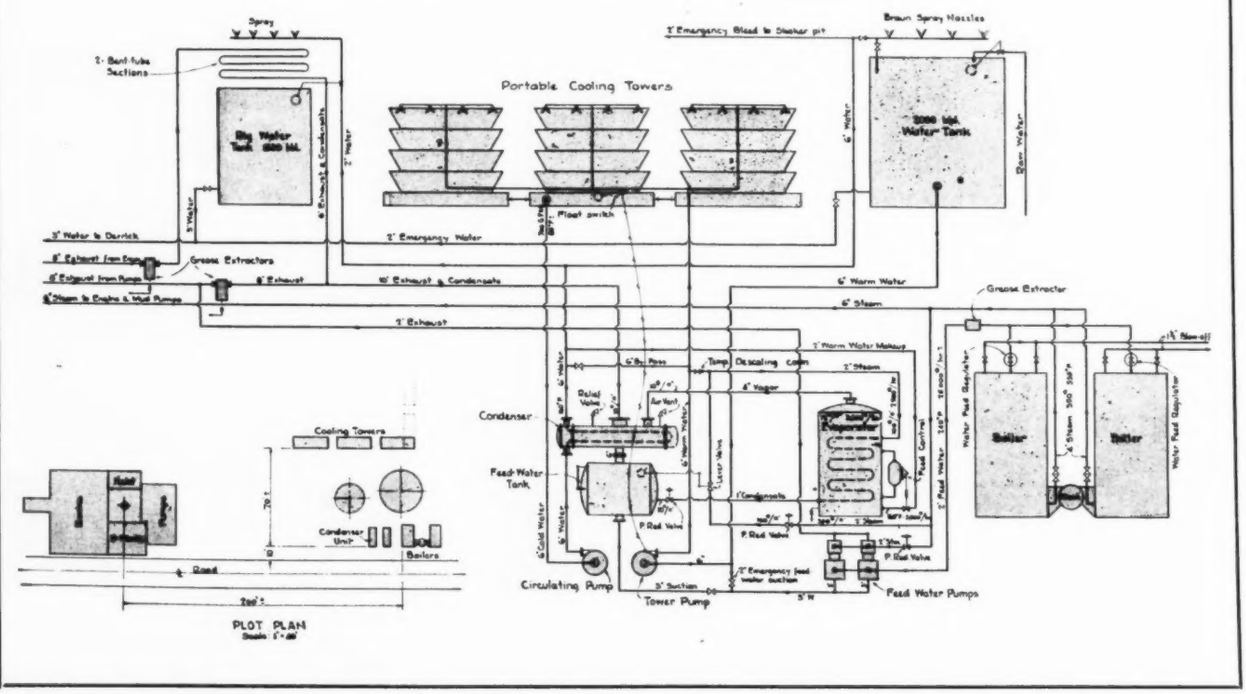
Boilers, complete	$ 36,000
Electrical Equipment:	
2—500-kw. turbo-generators 1—800-hp. drawworks motor with reduction gear 2—500-hp. mud pump motors 1—Control panel 2—5-hp. mud screen motors	
Total	$ 98,725
Evaporator and Condenser:	
1—Tubular-type evaporator 1—Single pass condenser 1—Circulating pump with turbine	
Total	$ 4,000
Drilling Equipment:	
Previous tabulation, less mud pumps and drilling engine	$52,500
Add:	
2—350-hp., 7¾ by 18 power pumps, 3000-lb. fluid end	23,000
1—Direct-acting weight indicator	3,300
2—Mud screens	1,800
	80,600
Boiler house, 24 by 60	1,500
Miscellaneous tools and supplies	7,500
Labor, rigging-up	5,000
	14,000
Barge including derrick and superstructure, delivered, floating type, no royalty	36,000
	$269,325

Two hundred and seventy thousand dollars—quite a sizable amount. Dictated from horsepower requirements back to the boiler plant, and by this token double the capacity of the four locomotive boilers. Consider four of the latter, at normal rating capable of delivering 18,000 lb. of steam per hr. It has been the writer's experience that 200 percent of rating is about as high as the locomotive type will ordinarily perform; hence 36,000 lb. versus 62,000 lb. One might say the marine plant is designed over-large, but the writer does not think so—proper power provision usually eliminates unintentional shutdowns.

In closing the writer wishes to express his regret that lack of time prevented him from including herein a comparison of the marine plant as indicated with a Diesel-electric plant of equal capacity and equal dependability. He feels quite sure, however, that this comparison should not be attempted without a great deal more study than has been applied to the foregoing.

[3] "Review of Advancements in California Drilling Practice for 1940," by A. H. Bell. Paper presented at A.I.M.E. meeting, Los Angeles, California, Oct. 17, 1940.

Fig. 4. Flow diagram of marine-type boiler plant *(Courtesy A. H. Bell)*



P 516.3

By
H. LEE FLOOD
Associate Editor

PETROLEUM ENGINEER EXCLUSIVE FEATURE

East Texas operator uses ammeter to advantage in balancing wells to maintain efficiency

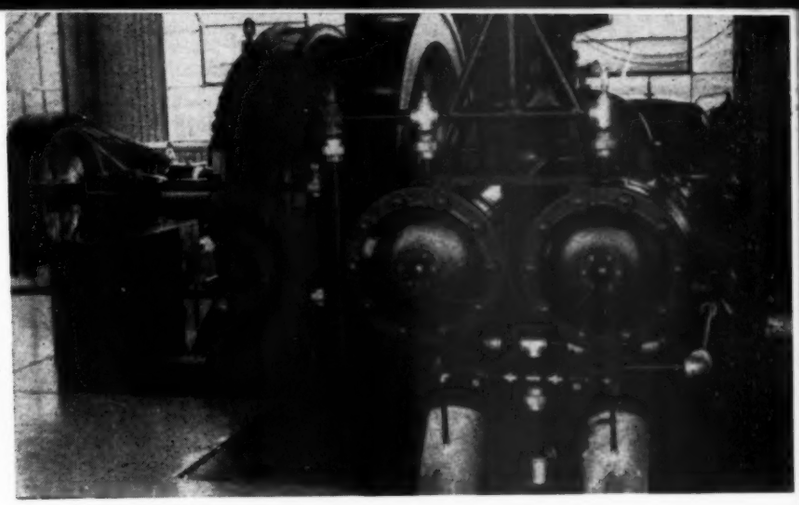


Fig. 1. Alternator direct-connected to 2-cylinder horizontal gas engine

Electric Power Provides For Flexible Expansion as Well-Pumping Needs Increase

ATTRACTING considerable interest among engineers with oil companies operating in the East Texas field is the electric generating plant installed and operated by General American Oil Company of Texas on one of its principal East Texas leases north of Gladewater, Texas.

Noteworthy is the manner in which the decision was made whereby this method of supplying power to pumping wells was selected. The problem was approached by the company's engineers with open minds, having no preconceived preferences for any specific power plan. Detailed estimates were set-up covering the expected costs of the several alternative programs that might be followed. Due consideration was given to first costs of equipment and to the annual fixed charges created, based on a reasonable estimate of the life and salvage value of the equipment; to the operating and maintenance costs under each plan, and, particularly, to the flexibility that would be provided for future expansion.

The latter factor—that of flexibility—is recognized as being especially important in the East Texas field because of the erratic performance of wells, even when side by side and producing from virtually the same depths in the Woodbine sand. On the lease being discussed, two wells now pumping may be separated by another well still flowing—all producing from the same depth.

Without going into elaborate detail concerning the choice of plans, it was this need for flexibility that dictated largely the selection of a central source of power so that the power requirements of individual wells might be served with as little surplus installed power as possible. Although motors have been installed having capacity to serve the increasing power requirements of the wells for some time to come and consequently are in all instances larger than the wells in their present condition require, full benefit is derived from the ability to combine all the smaller individual current consumptions of the several wells thus permitting satisfactory operation with much less installed horsepower in the generating plant than would be possible if, say, individual engines were installed at each well having the same provision for future needs of the wells. Inasmuch as the daily prorated allowable from these wells may be produced in only a few hours, there is the added advantage, when a central plant is in use, of being able to "stagger" the pumping wells so that a single generator may, if need be, serve a total installed motor load that is several times greater than the installed generator capacity.

The Generating Plant

Designed to provide power ultimately for all wells on the company's contiguous leases, the generator plant is planned so that additional generating units may be installed with a minimum of rearrangement. At the present time only one generator is installed.

Fig. 1 shows the prime mover and generator in operation. The a-c. generator, or alternator, operates at 300 r.p.m. and is rated 187 kva. at 0.7 power factor, a potential of 2400 v., 3-phase, and a frequency of 60 cycles. This unit is direct-connected to the 2-cylinder, 2-cycle horizontal gas engine of 14-in. bore and 18-in. stroke and rated at 180 hp. at 300 r.p.m. A belt-driven exciter serves the alternator, delivering 10 kw. at 1750 r.p.m., at a potential of 125 v.

The designers of this equipment, recognizing the severe fluctuations of power requirements inherent in a pumping well's cycle, have incorporated several features to meet the specific conditions encountered. A relatively large alternator operating at slow speed is employed in the belief that synchronization of two or more units will be easier than when high-speed, belt-driven units are used. Anticipating a low power factor in the pumping operation, a 0.7 rather than the conventional 0.8 power factor is provided. The ability to "ride through" high peaks is facilitated by the use of a heavier flywheel on the engine, so that the reserve kinetic energy stored

Fig. 2. Standard layout for motor-driven pumping wells on East Texas lease

Fig. 3. Control equipment is provided at each well

in the flywheel will be released when needed. The flywheel on the engine installed in General American's generating plant has a diameter of 85 in. and a 12-in. face, weighs nearly 8000 lb., and has a moment of inertia of approximately 70,000 lb-ft.^{2}

The building housing the generating unit is centrally situated on the lease adjacent to previously existing facilities that have no relation to the generating plant except that air-starting equipment and cooling tower capacity were already available, obviating the need for additional investment in these items.

Distribution System

More than the usual amount of study was devoted to the layout of the distribution system whereby electric power is made available to the pumping wells. Indicative of accepted sound engineering practice, all elements of the power system and particularly of the distribution system were designed with the ultimate development constantly in mind. This does not mean that the system is grossly overbuilt. On the contrary, a fairly flexible plan has been adopted throughout, calling for adequate size and capacity in those parts of the system that will remain fixed during the life of the project, but also providing temporarily for present requirements so that future developments, not now possible to predict exactly, will involve relatively little revision of present lines.

The 3-wire primary system, carrying 2400 v., is constructed of No. 2 wire, strung on wooden poles. Designed so that no more than 5 percent voltage drop is incurred in the lead to any well, even though the well load becomes a maximum of 20 hp., the transformer banks in the system are placed at strategic points from which the secondary system may be built to individual wells. Banks of two- and three-transformer installations have been made—all platforms have provision for a three-unit bank. Each of the banks having two 50-kva. transformers is at present connected "open delta" and has a capacity of 87 kva. If it becomes necessary to install a third transformer, the full capacity of 150-kva. for the bank of three will be realized.

Individual Well Equipment

The equipment shown in Fig. 2 is standard for all wells on the lease that are equipped with motor drive. At the present time, a total of 36 wells has been so equipped.

Depending upon a combination of present and estimated future requirements of the wells, either 10- or 15-hp., 440-v. motors have been installed at each well. Characteristically, these motors have a high starting torque requiring low starting current, obviously advantageous for pumping well service.

The wells on this specific lease are from 3600 to 3700 ft. in depth. With most of the pumps set "high" at about 2200 ft. depth, the power requirements now average approximately 3.3 kw. per well.

The control equipment at each well is housed in a metal cabinet mounted on a pole. Fig. 3 shows the interior of one of the control cabinets. All parts of the system are adequately grounded as a safety provision. Particularly valued by the workmen on the lease is the ease with which the electrical equipment may be placed in or out of service. Facilitating operation is the on-off switch placed on the front of each pumping unit, as shown in Fig. 4, within easy reach of the pumper when he is standing at the wellhead.

Studies of Well Performance

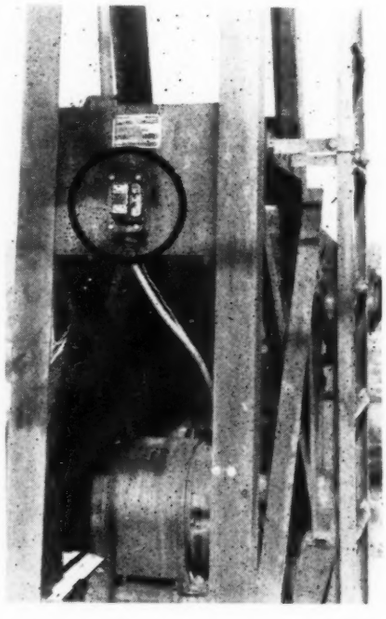
One of the advantages of electric power for pumping that is welcomed by the production engineer responsible for maintaining efficiency of the producing units is the facility with which the well can be accurately studied and its operation judged. The simplest manner by which this may be done is to use an indicating ammeter to observe the amount of current consumed at various phases of the pumping cycle. If recording instruments can be made available, a "card" should be obtained that will divulge information concerning the well as accurately as other forms of dynamometers.

Taking full advantage of this feature, General American's engineers are engaged in a study of individual well performance that should, when completed, contribute valuable information concerning the pumping characteristics of East Texas wells.

Aside from the value that will be derived from this extended study, the current consumption as indicated by an ammeter is used to adjust individual wells as conditions vary. By this means it is possible to detect unbalanced loads and shift the counterbalances accordingly. Likewise, it is possible to study the relation of pump depth and productivity index and adjust the pumping rate or change the depth at which the pump is set so that the best combination may be obtained.

As ammeter readings are made from time to time and adjustments are indicated, the engineer may avail himself of several methods to effect a change in the pumping operation. The pumping stroke may, of course, be varied. Strokes now being used on the various wells on the lease vary from 24 to 54 in. in 10-in. intervals. Pumping speeds likewise may be varied; to effect a speed change in the motor drive, the size of the V-belt pulley on the motor shaft is altered. A new type pulley is being used that permits exchanging pulley sizes by merely removing three cap screws that secure the pulley rim, permitting a larger or smaller diameter pulley to be installed.

Fig. 4. On-off switch (in circle) on front of pumping unit facilitates operation of motor



Refinery Practice for the Operating Man

Vocational Class Proceedings in Refinery Engineering

Review of Basic Principles of Cracking Reactions

Foreword

As a means of bringing to its readers information on the practical aspects of refining practice *The Petroleum Engineer* presents herewith the initial article of a series in which the proceedings of a vocational class in refinery engineering will be recorded.

In completing the arrangements whereby the class discussion has been made available, it was desired that the identity of the group remain anonymous. An effort has been made to preserve every feature of interest that would enable the reader to feel that he is, in effect, one of the class members. The material presented herewith represents the transcribed notes of a stenographer.

Better to acquaint the reader with the purpose and make-up of the group the following information may be of interest.

The members of the class are all employees of the same refinery in Oklahoma. The size of the group is limited to 25 members, of which 20 are graduate engineers and the other five are high school graduates who have devoted much of their spare time to the study of refining problems.

These men by voluntary agreement among themselves decided in the fall of 1938 to enter upon a course of study during the months of each winter in order that they could obtain a better understanding of some of the complicated advancements that are taking place in refining technology. Because the company with whom these men are employed acts only as an unofficial sponsor of the group, these men are to be commended for the spirit that has prompted their efforts.

In addition to a meeting of the main group of 25 once each week, other meetings are held on another night of each week by five study groups of five members each, broken down to facilitate discussion of the problems that are assigned by the main group leader.

During the two winter sessions, 1938-39 and 1939-40, the class reviewed fundamental chemistry and other elements of refinery engineering, using a recognized text book[1] as a guide.

At a meeting of the Executive Committee of three elected members, one of whom is the leader of the group, the following plan was formulated for the current winter's study:

1. The class will be restricted to 25 regular members, it being understood that visitors are welcome at all times.
2. The class will be divided into 4 or 5 study groups similar to last year's organization except that more care will be taken in the proper assignment of the class to the various groups.
3. The conduct of the classroom will be approximately the same as last year, with the first hour devoted primarily to working of problems previously assigned, whereas the second hour will be devoted to a theoretical discussion and preparatory work for the next week's assignment.
4. The course will run for 24 weeks, the first 12 weeks being devoted to cracking processes and the second 12 weeks to lube oil processes. An attempt will be made to develop these two refinery processes step by step from their simplest and earliest form to the latest modern developments that are known.

The following is an outline of the first 12 weeks' study:

First Week: Class organization and review of cracking chemistry. *Second Week:* Study of simplified cracking flow diagrams and functional explanation. *Third Week:* Study of time and temperature factors. *Fourth Week:* Completion of previous week's work and study of the pressure factor. *Fifth Week:* Methods and schemes used to control time, temperature, and pressure. *Sixth Week:* Continuation of Fifth Week's subject. *Seventh Week:* Effect of charging stocks on yield and quality of gasoline and other products. *Eighth Week:* Use of catalysts. *Ninth Week:* Effect of quench and recycle stocks. *Tenth Week:* Combination of cracking factors to make reforming, viscosity breaking, and coking operation. *Eleventh Week:* Study of dehydrogenation, polymerization, and other new thermal operations. *Twelfth Week:* Study of catalytic cracking processes.

At the first meeting the class voted to procure individual copies of a recently published text[2] as a guide for the study of cracking.

All blackboard sketches and other illustrative material have been reproduced as accurately as possible to enable the reader to follow the discussion.

The study group, recognizing that many of the points are controversial and that data, in some instances, are incomplete, will heartily welcome any comments that the reader may wish to offer. Communications to the group may be sent to THE PETROLEUM ENGINEER, P. O. Box 1589, Dallas, Texas.

[1] *Petroleum Refinery Engineering* by W. L. Nelson. McGraw-Hill Book Company, Inc., New York, N. Y.

[2] *Conversion of Petroleum* by A. N. Sachanen. Reinhold Publishing Corporation, New York, N. Y.

Class Meeting No. 1

Leader: The outline has been given to you for the 12 week course covering various factors in regard to cracking. Our text, "Conversion of Petroleum" by Sachanen, covers, I believe, enough of the factors in cracking so that we can use it to advantage in our study. I do not propose to begin on the first page and read it like "Time" magazine, but merely to pick out various portions of the book for each lesson. For example, the author discusses chemistry for 100 pages of the book, and the book comprises about 400 pages. That would mean that we would, if we organized our course on the basis of the book, use 25 percent of our time on the chemical reactions. I believe it would be much better if we would take the chemical reactions and try to fit them to the processing as the questions arise, and as we need to know the why and wherefore. This afternoon one of the members of the class brought out a point that I would like to hear repeated to the class.

Pupil: Perhaps you are referring to my saying that we will get the maximum amount of benefit out of our studies here if we can make chemistry a vital, living force and more than just dull statistics.

Leader: That's right, and I believe we can succeed in making this work interesting if all the members of the class will coöperate.

There are some of the members here who are going to be at a disadvantage due to the fact that they have not been in the class during preceding years, and I hope that the study will not get so far out of their range that it won't be interesting. We shall try to maintain your interest, but we are not going to guarantee to keep the speed of the class on a level with the understanding of these new members. The tempo of the class will be more to the upper half of the class. We have found that this method gives us more informative lessons and keeps everybody much more interested. You are not going to be graded at the end, so it doesn't matter.

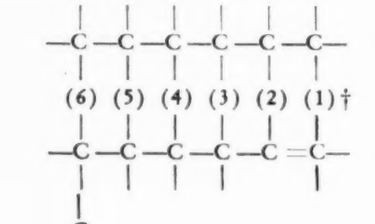
*Now, what are the fundamental types of hydrocarbons with which we

*This discussion is based on "Conversion of Petroleum" by Sachanen, pp. 1-38, inclusive.

shall be concerned in our cracking problems? These may be listed as follows:

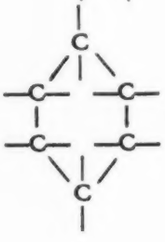
1. Paraffins
2. Olefins
3. Naphthenes
4. Aromatics

In order to establish an orderly understanding of these four different types, let us write the formulas in the usual manner to illustrate the positions and attachments of the carbon molecules:

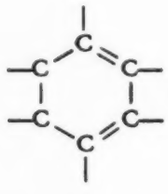


Normal Hexane . . . . (1)

Normal Hexene . . . . (2)



Cyclohexane(3)



Benzene . (4)

It will be noted that all molecules are of six carbon atoms listed in order of decreasing hydrogen content and that the symbols for hydrogen have been omitted, merely to save time in writing the expressions. In other words, each connecting link indicates that an H is attached, although it isn't shown.

Does the double bond in equation (2) mean that the chemical compound is stronger at this point or weaker?

Pupil: Weaker.

Leader: That doesn't sound right, does it? One of these bonds is not very tightly hooked on. One organic chemistry course we studied in school used to make us show one bond as a dotted line to indicate strong reactivity. What is the name of this compound [pointing to equation (2)]?

Pupil: Hexene 1.

Leader: Now, the naphthene [pointing to equation (3)]. It also has six carbon atoms, doesn't it? Remember, whenever we do not put the symbol H on the bond, that doesn't mean there isn't a hydrogen on the end; it means we are merely being too lazy to put it on.

†These figures indicate the number of carbon atoms.

In this case, you will notice that the carbon atom is hooked to another carbon; that two of the valences of the carbon atom are satisfied by other carbon atoms, but not in the same manner as in the unsaturates. What about the chemical stability of this particularly hydrocarbon?

Pupil: Stability is good.

Leader: How does it compare with a saturate?

Pupil: It is slightly less stable.

Leader: Is it less stable on this particular compound (cyclohexane) or as a class?

Pupil: As a class.

Leader: Would you say that this [again pointing to equation (3)] was less stable than a normal paraffin hydrocarbon with a longer chain?

Pupil: No, the longer chain would be less stable.

Leader: Yes, but if you extended the paraffin hydrocarbon to a 15- or 20-carbon chain, the cyclohexane would then be more stable. Now the aromatics; what is the name of this [pointing to equation (4)]?

Pupil: It looks just like cyclohexane except that it has an alternate double bond. It is termed benzene.

Leader: What is its relative chemical stability?

Pupil: It has much less resistance.

Leader: How does it compare to the olefin?

Pupil: It is more stable than the olefin.

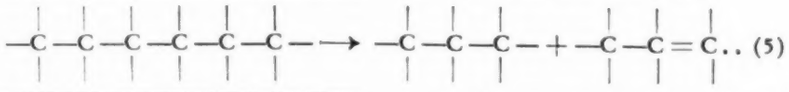
Leader: In summarizing the effect of cracking on the various classes of hydrocarbons, we can make the following generalized statements:

The paraffinic group is most susceptible of all the hydrocarbon groups to cracking, which means that these compounds are decomposed at a lower temperature than the other hydrocarbon groups. It is further less well-established that in the primary cracking reaction, the hydrocarbon breaks near the middle of the molecule. The cyclic or ring compounds have generally greater stability than the paraffinic or straight chain carbons, with the aromatics more stable than the naphthenics.

Having made this brief outline, the rest of the evening's discussion will be confined merely to the reactions of the paraffin hydrocarbon. The olefin is not found very much in crude oil. Is that right? (Voice from class: Yes.) They ordinarily are formed as the result of cracking a paraffin. How about the naphthene? This is one of the natural compounds found in crude oil. How about aromatics? They are also mostly formed by the cracking of the olefins so that the chances are that if we begin to understand how the paraffins act, we shall be able to go on to these other compounds without much difficulty. We will just drop the more complicated three classifications and take the plain paraffin. Why is there cracking? Under what laws of nature is cracking possible?

Pupil: You mean by heat?

Leader: Before answering that, perhaps we had better put down the chemical reaction first. Maybe that will help. [See equation (5).]



(5)

In this reaction, where will the cracking be most apt to take place? As written, that is at least a probable and possible cracking reaction, isn't it? That we would crack normal hexane and we would get butene and ethane. How does this occur?

Pupil: Increase in temperature of the chemical reactions immediately becomes more pronounced. The carbons break their bonds.

Leader: Then this reaction has to occur under certain specified conditions. Would you apply heat or work?

Pupil: Work.

Leader: But you can express this energy as heat. You really add the thermodynamic symbol ΔF° (*see Sachanen, p. 11*) to this hydrocarbon to get that reaction. Then the cracking reaction should be considered under the laws of thermodynamics; which law?

Pupil: The first one.

Leader: Which is the first one?

Pupil: "Lost" energies merely change from one form to another and are not really lost.

Leader: In a change of state, no energy can be gained or lost—is that the idea? Well, you are changing this molecule into two or three other molecules by the addition of heat; then there must be more energy in the final products.

Pupil: No.

Leader: Well, then what happens to the energy?

Pupil: It is retained in a new compound form.

Leader: And doesn't that give off heat? What is the cracking reaction? Does it gain or lose heat?

Pupil: Gains heat.

Leader: In other words, you can't get out of the cracking reaction the amount of heat you put in?

Pupil: Yes.

Leader: You added heat to hexane and yielded other products, butene and ethane, and there was heat absorbed in that reaction; therefore, these products must have more energy than the original stock—is that right?

Pupil: Yes.

Leader: What does that mean?

Pupil: Heat of decomposition is included in the products of the cracking reaction.

Leader: Does this give you any clue—is that any basis for approaching the study of cracking operations?

Pupil: Some of the energy was given off as heat, but it hasn't been lost or given up.

Leader: Would you get more energy out of butene and ethane than out of hexane?

Pupil: It's according to the way they are used.

Leader: In the discussion of heat of decomposition, or heat of formation, you may arrive at these values by comparing the heating values of the products yielded from a cracking reaction; for example, by comparing the heating value of hexane with the combined heating values of two products, butene and ethane, which may be yielded from the cracking of hexane, we can arrive at the heat required to convert hexane into butene and ethane. If we know the reaction that takes place, it is possible to calculate the heat required to conduct this reaction.

Pupil: You get more energy out of the two products than you would out of the n-hexane.

2nd Pupil: Wouldn't you take the sum of the heating values on one side plus the heating values on the other?

Leader: We are not going to lose any heat or energy in this reaction. We're merely changing it. What do you think? Do you believe that those products will yield a greater amount of energy than is in the starting material?

Pupil: If there is endothermic reaction there, then there is energy absorbed by this process and then when you reverse that or tear those up, you will get more heat out of the butene and ethane than you will from the n-hexane. You do not lose energy in the reaction; in other words, all the energy that goes into a still comes out in one form or another; either through the flue gas or the product manufactured.

2nd Pupil: The heat of combustion of the product formed will be equivalent to the heat of combustion of the product cracked plus the heat added.

Leader: Let us put another arrow in equation (5) ($\rightleftharpoons$) indicating a reversible reaction. That would indicate that this reaction is in equilibrium, but in order for this reaction to go in the reverse direction, we have to add energy and the temperature remains the same. It is an isothermic reaction. The temperature on the left side of the reaction is the same as the temperature on the right side, but we have added extra heat so that the products on the right at this temperature must have more energy than the products on the left at the same temperature.

If you increase the amount of heat on the left side of the reaction, will that change the products on the right? All right, then, we should be able, on this basis, to predict from the amount of heat we add what the products will be. Is that right? Or if you know what you want to make and know what you want to crack, you can take the difference in heats of combustion between the two and know what you have to add. What effect will more heat have on this product?

Pupil: It will cause additional cracking.

Leader: It will drive the reaction further, to make elemental carbon and hydrogen. The ultimate here is that we shall get carbon and hydrogen, and by the proper application of heat and addition of the correct amount of heat, we can control the cracking reaction. Is that right? Well, is everybody happy about this now?

Pupil: I think we might be able to control it up to a certain point, but beyond that we wouldn't be able to.

Leader: The application of heat to the hydrocarbon is a determining factor in the simple conversion of petroleum. What method is used in order to predict these reactions and the products? Has any work been done along that line?

Pupil: A great deal of work has been done.

Leader: Is it of any practical value, do you believe?

Pupil: Yes.

Leader: Sachanen has an equation, shown on page 11 of the text. This is credited to Thomas, Egloff and Morrell:

$$\Delta F^\circ = 10{,}550 - 5.890n + 25.2nT - 2.2T \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

That expresses the free energy or formation of *n*-paraffin hydrocarbons in the gaseous state. The *n* refers to the number of carbon atoms and the *T* to absolute temperature. ΔF° is the free energy of formation. This is the same symbol we had before, which designates the free energy of formation from the elemental state. Now by reference to the text, you will find that there are a great many other formulas that look very much like that for each individual reaction. What is the significance of that formula, do you believe?

Pupil: You mean practically? It will give the difference in heat requirements for cracking various charging stocks. Begin with the naphtha for reforming or, say, residuum for cracking and it will give an idea regarding the heat or temperature required.

Leader: How would this be expressed? In calories?

Pupil: Well, practically—in B.t.u.'s or calories.

Leader: Is that a positive or a negative reaction?

Pupil: That would depend upon the temperature and the number of carbon atoms.

Leader: What would be the significance of the minus sign in equation (6)? What would that indicate?

Pupil: It would indicate that heat was being given off in formation.

Leader: Would that indicate that there was sufficient energy to form the hydrocarbons?

Pupil: If the whole thing were minus.

Leader: What would it mean if it were a positive sign instead of a negative?

Pupil: It would require that much heat to form it.

Leader: What, then, would be the significance if it were zero? Would that represent a condition of equilibrium?

Pupil: Yes.

Leader: In other words, if you would make a substitution in this formula [equation (6)] which would cause the equation to be zero, this temperature condition would be the minimum temperature at which cracking would be likely to take place?

Pupil: To keep it all clear, isn't that formula beginning with the elemental material and building to the hydrocarbon the exact opposite of cracking?

Leader: Yes, but it is a matter of understanding the meaning of plus or minus values.* All right, then, equation (6) expresses the amount of energy required to form the hydrocarbon from the free molecule. If we should substitute in this equation so that it would come out zero, that would be the temperature at which the cracking reaction or this formation might begin. Is that right? Well, now here is

*See Sachanen, p. 14 for clarification of plus and minus values of free energy equations.

an interesting thing. Sachanen gives a table of zero-free energy values. These are elemental:

	Dehydrogenation temperature, °F.	*Decomposition temperature, °F.*
Ethane	1448	
n-Butane	1196	599
n-Decane	1033	498
n-Eicosane	831	378

Does anyone know how many carbon atoms in eicosane?

Pupil: Twenty carbon atoms.

Leader: The first column shows the zero-free energy values for the equation that represents dehydrogenation and the other column, the zero-free energy values for decomposition.

Pupil: The table shows no value for decomposition of ethane; you can't decompose ethane to two compounds that contain carbon-deficient hydrocarbons.

Leader: You can't crack ethane without yielding a pure element. That is dehydrogenation.

Pupil: The larger molecules are the easiest to crack.

Leader: It shows one thing: That the lighter molecules require greater temperature for decomposition. It shows, just as in our discussion of equation (6), that the elemental breakdown requires more heat or energy than the simple cracking reactions. It also shows one rather interesting thing to me, and that is that normal decane at 500° is in a state of equilibrium insofar as the cracking tendency is concerned. Sachanen mentions here in the text that ethane is very difficult to crack.

Pupil: Does he give any pressure?

Leader: What difference does pressure make? Would pressure retard the reaction? Or increase it?

Pupil: Increase it.

Leader: Why?

Pupil: You use pressure to increase reaction.

Leader: Well, I've got the advantage of having studied my lesson, which the rest of you could not do since the texts have not yet arrived. According to the author, the only advantage of pressure is based on the economics of the equipment. Merely the size, mass, and bulk of the equipment.

Pupil: Every once in a while some other author wants to take exception to that, too.

Leader: Well, we do not have to accept the text, but we are going to have to take Sachanen's arguments and accept them or else find better ones.

Pupil: In other words, for hexane—you start out with one volume of gas and crack that to ethylene and hydrogen and on doubling the pressure, will it start back in the direction of ethane?

Leader: You mean you can force the reaction by pressure?

Pupil: Yes.

Leader: When you are at the equilibrium you can change it.

(Note to readers of *The Petroleum Engineer:* The members of the study group would appreciate information on the reversibility of the cracking reactions.)

Pupil: Do you mean that when it passed the critical point that the size of the molecule wouldn't make any difference—that you would have the same volume anyway?

Leader: I can't see how pressure would have any effect except that as you take a particular gaseous mixture and increase the pressure you would also increase the temperature. That would be the only effect, the change in temperature.

Pupil: That's all that can take place in the gaseous state, isn't it?

Leader: These reactions discussed have all been in the gaseous state. We really are getting a little ahead of our discussion anyway, and that is one of the technical discussions that I wanted to carry on in connection with equipment. I believe we can discuss more intelligently and perhaps reach better conclusions on the matter of changes in state if we consider them at the same time we discuss the actual processes.

Our discussion thus far represents the introduction to the cracking reactions. It isn't so much chemistry as it is thermodynamics. In other words, you have a chemical reaction explained by thermodynamics. The recently publicized Polyform process involves a great many angles along this same line. What I mean is that the process is apparently based on a thorough understanding and knowledge of these very principles we have discussed.

Pupil: It would take quite an elaborate analysis of the product to be cracked to know what you are doing, wouldn't it?

Leader: That is one reason why Phillips Petroleum Company in their neohexane plant have done so well; they were not using an indiscriminate batch of hydrocarbons. They actually began work on a pure compound and developed the process on theory. The Gulf polyform operation is an effort to apply general formulas to the bulk or mass of hydrocarbons working in the gaseous phase. I don't think there is any question but that cracking today is being developed along these lines. I do not believe that there is so much cut-and-try development as formerly. They are analyzing their reactions and predicting what might happen and trying it out and perhaps by combination of theory and practice working out a finished process.

Pupil: Don't you think the cut-and-try method is still prevalent on longer chain molecules?

Leader: Yes, the Gulf polyform unit operates on definite minimum and maximum requirements of C_3 and C_4 compounds for correct equilibrium conditions. That was probably a cut-and-try method, but I imagine they also applied a great deal of theory to it.

Pupil: In cracking the longer chain compounds, they know now how to reduce to the simpler ones and then, using these simpler ones, get more precise results. There is no such thing as passing something through a still once and calling it finished.

Leader: I should like to read from p. 38 of Sachanen "Summary of Cracking Reactions of Paraffins" (Reading):

"On the basis of the foregoing paragraphs, the most probable cracking reactions of paraffins are: splitting decomposition, forming a paraffin and an olefin, and dehydrogenation, forming the olefin of the same carbon number. The probability of dehydrogenation decreases with increasing molecular weight of the paraffin. The high molecular weight paraffins for the most part undergo various carbon-carbon splitting decomposition reactions, the rupture of the chain taking place at various carbon-carbon bonds, but most frequently in the middle of the chain.

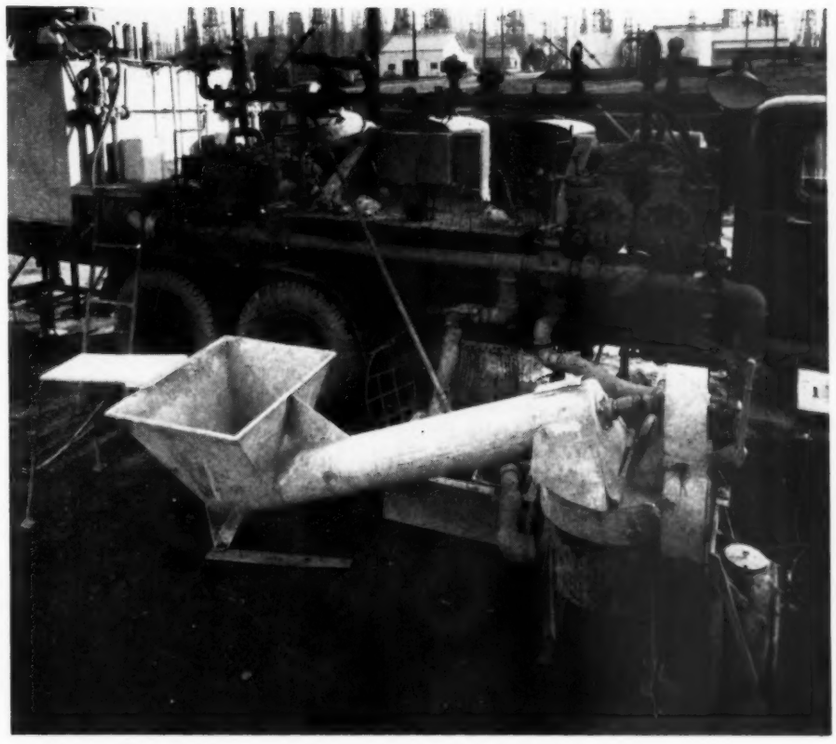
"The partial alkylation of paraffins with olefins at high temperatures may take place under sufficiently high pressures. The isomerization of paraffins is improbable in the non-catalytic process.

"These processes are the primary decomposition reactions of the paraffins. A series of secondary reactions follows the primary reactions, and these involve the formation of low molecular weight paraffins and olefins. The former are mostly decomposed further or partially alkylated, if the pressure is high. The olefins are either polymerized or further decomposed, depending on the conditions of cracking. On the other hand, they may be transformed into naphthenes or aromatics."

For next week, I have chosen Chapter 4, "Basic Principles of Cracking Equipment." Take pages 225 to 248, and in conjunction with that, let's review these cracking reactions of paraffin hydrocarbons, pages 9 to 38. In connection with the lesson, I should like to have each member of the class trace the evolutionary steps in cracking design. What we shall try to do is begin where the industry began 50 years ago at the beginning of modern cracking. We shall attempt to trace the steps that were taken to improve the operation and process. I should like to have you also make a flow sheet of facilities to obtain a high liquid gasoline yield from 26° A.P.I. Kansas residuum.

EDITOR'S NOTE: Proceedings of additional class meetings will appear in subsequent issues of *The Petroleum Engineer.*

Equipment with which proportioning of calcium carbonate and cement is accomplished



A PETROLEUM ENGINEER EXCLUSIVE FEATURE

By
WALLACE A. SAWDON
Pacific Coast and Foreign Editor

Exposed area of producing formation may be materially greater when acid is used to remove cement behind casing or liner.

Acid-Soluble Cement As An Aid In Increasing Flow Through Gun-Perforations

THE practice of cementing a liner or casing string through a productive zone and then gun-perforating to admit the flow of oil into the hole is now widely recognized as an effective means of well completion under certain conditions. Also, the use of gun-perforating to open-up a zone previously cemented-off has been a successful procedure. The bullets shot by the gun quite evidently pierce the pipe and the surrounding encasement of cement and provide openings for the oil to enter the liner or casing. To assure an unobstructed passageway through the shot holes, however, and thus increase the effectiveness of the shot, an acid-soluble cement has recently been employed in cementing the pipe in a number of wells in California.

The acid-soluble cement is made by mixing approximately equal parts of any type oil-well or Portland cement with a specially prepared calcium carbonate. The physical properties of the resulting cement are governed by the characteristics of the calcium carbonate. The latter chemical differs considerably from that now being used for conditioning mud fluid prior to acid treatment for removal of the mud sheath from the wall of a producing sand. This product was developed by Frank Dieterich, research chemist of Los Angeles, and the jobs performed to date have been done under the supervision of J. Kenneth Kennelly, chemical engineer for International Cementers, Inc.

In developing the calcium carbonate best suited for making acid-soluble cement the objective, of course, was to produce a cement comparable to the neat cement now being employed for specific purposes, the actual kind of cement required (an oil-well or construction cement of desired type) being mixed with the calcium carbonate. Numerous tests were made before the cement was used in actually cementing a well and the general physical characteristics disclosed are indicated by Table 1. The tests also showed less shrinkage during setting as compared to neat cement. A comparison with one type of oil-well cement is shown in Table 2. The solubility in acid is given graphically in Fig. 1.

Although evidence is still lacking on which to base definite requirements concerning the strength of cement for different oil-well jobs, a reduction in shrinkage is always desirable as excess shrinkage not only may cause cracking but will tend to weaken the bond between the cement encasement and the wall of the hole. The shattering of the cement around the pipe by the action of the tools going in and out of the hole is believed by some engineers to be a frequent occurrence, particularly when the clearance is small; and it is asserted that tests have indicated the acid-soluble cement to show less shatter than neat cement. Another factor that may have an influence on the success of a cement job is the scouring effect on the walls of the hole that probably accompanies the abrasive action caused by the calcium carbonate in the slurry.

The quantity of set cement that can be dissolved with any unit volume of acid is fixed and depends on the area of contact of the acid and the cement. The amount of cement dissolved is therefore less when the area of contact is small than when the area of contact is large, and as the acid spends itself a protective coating is formed on the cement that inhibits further action. When acidizing via a hole through this cement there is thus no danger of the

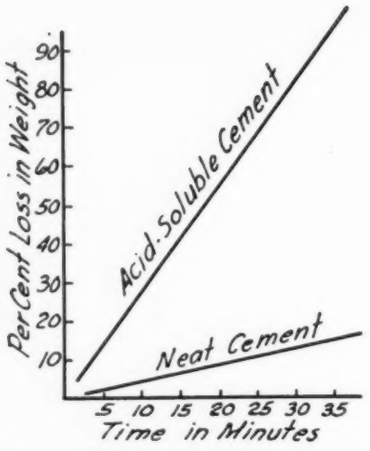


Fig. 1. Relative solubilities of acid-soluble cement vs. neat cement in hydrochloric acid

action of the acid extending to a point where the effectiveness of the cement as a water shut-off will be impaired. In fact, the shot hole may not be enlarged to any great extent but it will be cleaned-out to the sand and any clogging by cement that has been shattered by the shot will be removed. Considering further the shut-off properties of the cement, tests have shown that the acid-soluble cement stands up as well in the presence of sulphate or salt water as neat cement of the same make and type as that mixed with the calcium carbonate.

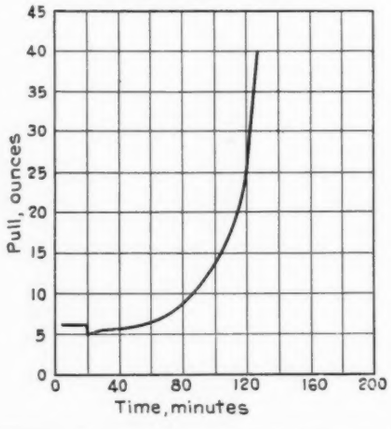
Mixing of the calcium carbonate with the cement is done at the well with two cutting boards, one for the cement and the other for the special calcium carbonate. As when using any kind of cement, the amount of water may vary with the requirements of the job. On the jobs that have been done to date the slurrys have averaged approximately 118 lb. per cu. ft. (16.75 lb. per gal.) and the thickening rate has been about the same as that of a 40 percent neat slurry.

The thickening time rate of acid-soluble cement slurry is shown in Fig. 2.

Several different kinds of jobs have been performed with the acid-soluble cement. In most cases the acidizing of the shot holes has been done at the time of or immediately following the gun-perforating operation; but in some cases the well has merely been gun-perforated. The acid-soluble cement was employed in such cases to provide for acidizing at a later date when production declined. The various types of jobs are illustrated by the accompanying drawings.

In the well illustrated in Fig. 3 a blank string of 6-in. casing was run to bottom at a depth of 3191 ft. and cemented through four oil sands, 110 sacks of acid-soluble cement (made of slow-set cement and special calcium carbonate) being used for the job. Tubing was run to bottom and the casing was filled to the 2010-ft. depth with a chemical plug consisting of water to which sufficient calcium chloride was added to bring the specific gravity of the liquid to 1.08 or more. This chemical plug is generally known as "heavy water" and the admixture is termed a water-soluble weight material. Acid was then spotted above the chemical plug to extend to the top of the uppermost sand at a depth of 1960 ft. With the acid in place the pipe and cement were gun-perforated. As the pipe and cement

Fig. 2. Typical thickening time graph for acid-soluble cement



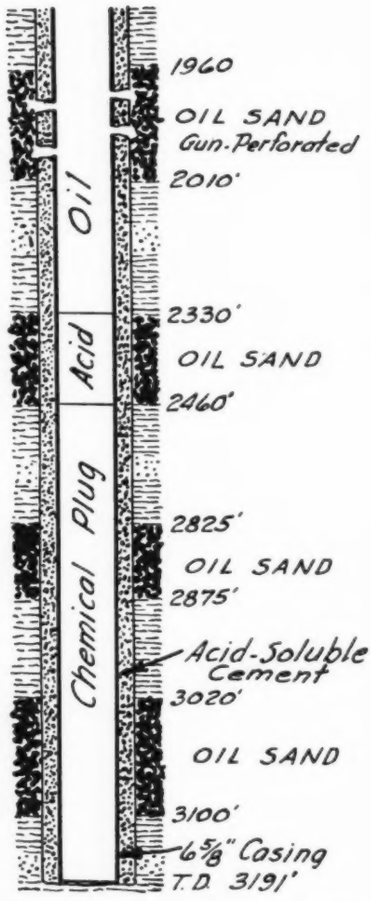


Fig. 3. Hole prepared for gun-perforating to admit acid to a lower zone after upper zone has been treated

are being penetrated with the gun firing in an acid-filled hole, the acid follows the bullet and it is believed that this method of acidizing the cement through the bullet hole is most effective.

The hole above the chemical plug was then washed with a pressure washer and the well tested for a few days. After this test was completed tubing was run to a depth of 2460 ft. to circulate oil and thus displace the water plug through and above the second zone. Acid was then spotted opposite the second zone so that the sequence of liquids in the hole from the bottom up was (1) heavy water to the bottom of the second zone (2) acid through this zone, and (3) oil above and through the zone previously tested. The second zone was then gun-perforated. The same procedure was followed with the third and fourth sands below.

A limestone-mud fluid was used in drilling the bottom portion of the well shown in Fig. 4 so that the perforated section of the 6⅝-in. casing and the sand opposite the perforations could

TABLE I

Physical Characteristics

Time	Tensile strength, lb. per sq. in.	Compressive strength, lb. per sq. in.	Thickening Time (40-oz. pull)
Acid-soluble cement made with modified oil-well cement			
Slurry			130 min.
1 Day	393	2609	
3 Days	403	3228	
7 Days	602	4081	
Acid-soluble cement made with construction cement			
Slurry			86 min.
1 Day	318	2210	
3 Days	346	2778	
7 Days	375	3165	

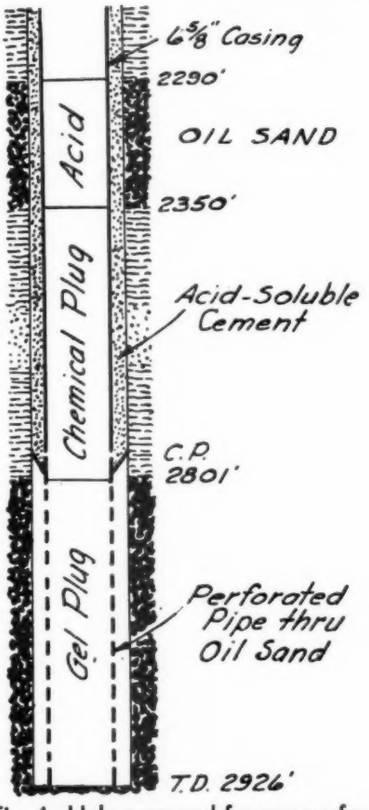


Fig. 4. Hole prepared for gun-perforating to admit acid to upper zone

be acidized for removal of the mud. In cementing the casing 250 sacks of acid-soluble cement was used to cement above the perforated section of pipe and through an oil sand above. After the perforated section of pipe had been cleaned-out by acidizing, the well was completed for a test.

The hole was then filled with a gel plug from bottom to 2801 ft. and with heavy water from 2801 ft. to 2350 ft. The gel plug protected the oil sand from water and acid as it solidified when placed in the hole. This type of plug returns to liquid form after a predetermined period, in this case 36 hours, due to bacterial action on the material in the plug. Acid was spotted opposite the upper oil sand from 2350 ft. to 2290 ft. and the pipe and cement were gun-perforated to test this sand. The well was then washed and completed to produce from both sands.

In another well recently completed, 130 sacks of acid-soluble cement were used to cement a blank string of 5½-in. liner for approximately 1500 ft. from bottom at 7400 ft. This well was gun-perforated at a lower producing zone near bottom without the use of acid and the well thus completed. These gun perforations can be acidized when necessary and upper zones, now cemented-off, can be gun-perforated and acidized at a later date.

There are cases where it may be desired to have a portion of the cement behind the pipe acid-soluble and the remainder neat cement. In one well drilled to a depth of 5760 ft. with 7⅝-in. hole, a combination 5½-in. string was perforated from 5680 ft. to bottom and the cement was placed above the perforations. The cement was to extend to approximately 2800 ft. but only the 600 ft. above the perforated section was to be gun-perforated. Three hundred sacks of neat cement were first pumped in and this was followed by 100 sacks of acid-soluble cement without interrupting the cementing operation. The neat cement was a modified oil-well cement and the cement used with the special calcium carbonate was a special oil-well cement. The acid-soluble cement was estimated to extend from 5680 ft. to 4880 ft. The hole is to be filled with acid from bottom at 5760 ft. to 4880 ft. and the pipe gun-perforated above the perforated section.

Another example of the application of acid-soluble cement has been in cementing liner with perforated sections where the cement necessarily came down over the face of the formation behind the perforated portion of the pipe. The acid in these cases was placed so as to act on the cement through the perforations but not behind the blank sections of the liner where the cement served to shut-off water. There will probably be various applications of this type of cement for purposes not indicated by the jobs performed to date but, because they have not yet been tried, these will not be discussed here.

TABLE 2

Shrinkage

Contraction in percent of length of standard expansion bar. Acid-soluble cement made with oil-well cement.

Time	Acid-soluble cement	Neat cement
1 Day	0.007	0.009
3 Days	0.073	0.118
5 Days	0.137	0.198
7 Days	0.161	0.243
8 Days	0.170	0.258

Showing the hopper in which the calcium carbonate and cement are mixed

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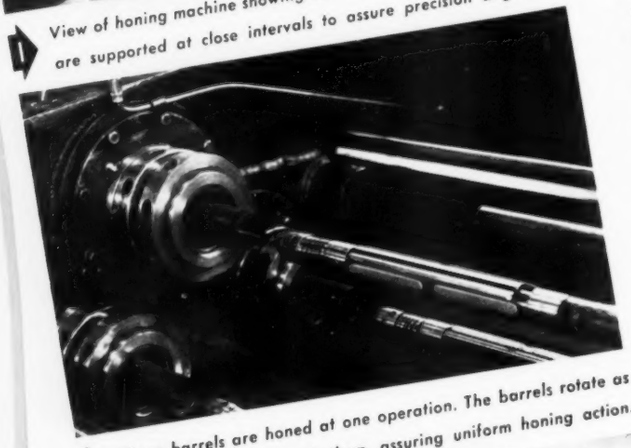
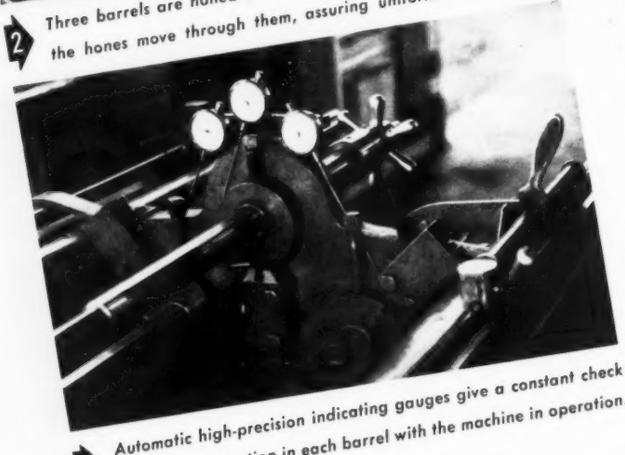


2 Three barrels are honed at one operation. The barrels rotate as the hones move through them, assuring uniform honing action.



3 Automatic high-precision indicating gauges give a constant check on the honing action in each barrel with the machine in operation.

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Designed and built by Flupaco for the special purpose of honing the "Improved Insert" and "Groove Seal" one-piece barrels, the honing machine shown at left produces finished barrels of perfectly uniform, true and highly polished bores. With its precision indicating gauges and perfect control, it brings to Flupaco barrels an accurate finish that gives exceptionally long service. In fact, without this machine—part of the complete new manufacturing process developed by Flupaco for the one-piece barrels—their economical production would not be possible!

This machine is another example of how Fluid Packed Pump Company leads in new designs . . . new manufacturing methods . . . new pumping efficiencies. Next time you buy pumps—no matter what the application or well condition—investigate the Fluid Packed way of cutting pumping costs!

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Service Records Indicate Value of Horizontal Return Boilers Equipped With Water Wall Tubes

A PETROLEUM ENGINEER EXCLUSIVE FEATURE

Need for greater efficiency in small steam plants stimulated new design —First cost and increased steam production rates are favorable

By F. L. KALLAM
President, Industrial Engineers, Inc.

THE spectacular innovations in water-tube boiler design of recent years have practically eliminated the horizontal return tubular type from mention in the literature. Actually, however, this type of boiler continues to lead in total number of installations and total generating capacity.

The field that the horizontal return tubular boiler still dominates, and for which it is particularly suited, is that of the small industrial power or heating plant. By reason of the size limitation of this boiler, no unit is ever especially designed for a particular plant service. They have always been manufactured in standard sizes and in large quantities that make prices favorable, and have been accepted, installed, and operated as they were. For these reasons, the horizontal return tubular boiler has received little design consideration during the last 30 years and so continues to wear the same old familiar suit of clothes.

Now, however, even the small industrial plant can no longer tolerate the 60-65 percent boiler and furnace efficiency so common in 1930. Yet the fuel burning practices and superequipment of large plants cannot often be utilized because of the high initial cost and because expert skill for operation is not available in the smaller plant. In an effort to obtain "more steam from less boiler" in the small plant, at reasonable cost and simplicity, a design has been developed in which the conventional horizontal return tubular boiler has been supplemented with water walls. This design has proved exceptionally successful in 14 installations in the oil refining industry, the oldest of which has been in continuous 24-hour service for more than ten years.

All installations have been 150-lb., 150-hp. units with 72-in. diameter by 18-ft. long shells, containing eighty-four 3½-in. O.D. by 11-gauge tubes, affording 1488 sq. ft. of heating surface. Each boiler is suspended 8 ft. above the furnace floor by special steel structural members that also support the 36-in. dia. by 80-ft. steel stack.

F. L. KALLAM

received an A.B. degree from Stanford University in 1921 and an M.E. degree from the same school the following year — His affiliations with various companies connected with the petroleum industry, given chronologically, follow: engineer, C. F. Braun and Company, 1923; gas engineer, Shell Oil Company, Inc., 1924; construction engineer, Pan American Petroleum Company, 1925; construction engineer, Shell Oil Company, Inc., 1926; superintendent, Mutual Gasoline Company, 1927; in charge of petroleum research and development, Southwestern Engineering Corporation, 1928-30; chief engineer, Natural Gasoline Department, Foster Wheeler Corporation, 1931-33, and in 1934 founded Industrial Engineers, Inc., Los Angeles, California, of which he is president—Is holder of 8 U. S. patents on methods of vapor-pressure control and manufacture of natural gasoline—Has written more than 70 published papers and articles on subjects pertaining to manufacture of natural gasoline and kindred subjects—Is co-author with A. F. Semino of book entitled "Correct Design and Operation of Heat Exchangers."

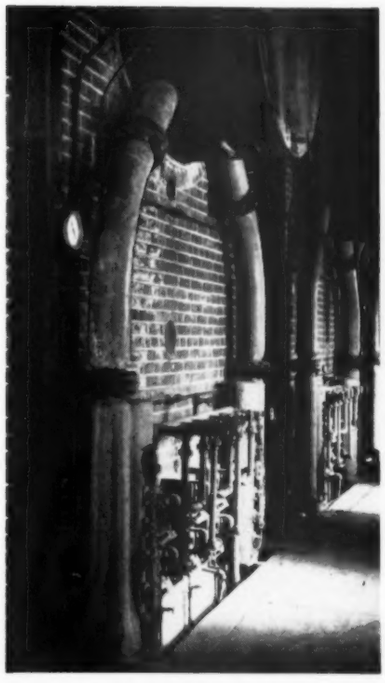


Fig. 1. Front of boilers showing 4-in. piping to water-wall headers

Each boiler is placed in a separate brick setting, consisting of 18-in. walls made up of 9-in. fire brick. The rear arch is of flat design, using special iron tee-bars to support the fire brick. Foundation for the structural steel supports and brick walls is of reinforced concrete protected from the furnace heat by fire brick. The furnace floor is air-cooled by the use of tile ducts whereby secondary air for the burners is taken from outside the rear of the boiler setting.

Burners are arranged through the front wall in a double bank of three, and are designed to use 1500 B.t.u. fuel gas.

As shown in Fig. 1, the boiler is fitted with special 4-in. downcomer piping leading from the lower portion of the front tube sheet, through the smoke-box extension, and terminating in two water wall headers situated outside the setting. These headers are square in cross-section and each is provided with handhole plugs opposite the water wall tubes terminating in each header. The tubes are rolled into the headers through these handholes, which also serve as inspection and clean-out openings.

The water wall tubes terminate in similar headers situated at the rear of

Fig. 2. The water-wall headers at the rear of the boiler are at a higher elevation than the front headers

the boiler as shown in Fig. 2. As will be noted, these two headers are at a higher elevation than those in front, and are attached to the boiler shell by means of curved upcomer piping. These 5-in. upcomers are connected into the boiler above the top row of tubes approximately 5 ft. from the rear tube sheet. As is apparent from the relative position of the headers, the water wall tubes are inclined from front to back at an angle of 9 deg. with the horizontal, and are bent only at their ends to facilitate rolling into the headers. All upcomers, downcomers, and headers are appropriately insulated. The water circulates through the walls by thermo-syphon effect from front to rear.

Fig. 3 is a view within the combustion space looking toward the burners in the front wall. The water wall tubes can be seen entering the furnace through this wall from the downcomer headers in the front. Water wall tubes are of ordinary carbon steel, 3-in. O.D. by 9-ga., and are placed 1 in. from the side walls, the total outside surface being 179 sq. ft.

The rear end of the furnace setting showing the protection pier for the blow-off piping can be seen in Fig. 4. The inclination of the water wall tubes is plainly evident in this view. The tubes pass through the rear wall to the headers shown in Fig. 2.

Attention is called to the perfect condition of the furnace walls, shown in Figs. 3 and 4, which are typical for this design of boiler. At the time these pictures were taken this particular setting had been in constant 24-hour duty since March, 1936, operating at from 250 to 320 percent normal rating, with exception of down time for cleaning and inspection. The condition of the walls, both inside and out, attests to the fact that the water walls absorb the heat at a very rapid rate and so protect the brickwork from the usual deterioration. In operation, the fire brick behind the water wall tubes appears black in contrast to the rest of the furnace. The only expense incurred during this operating period has been the purchase and installation cost of two sets of rear arch bars.

These boiler installations are operated in plants where the raw water make-up is minimum because of the large percentage of condensate return. In all cases some inexpensive treatment is employed to control the corrosion and maintain a favorable caustic embrittlement ratio in the feedwater.

Operating performance from these boilers has been very satisfactory as is evidenced from the experience in one plant. Originally this plant operated its 150-hp. boiler, having 1500 sq. ft. of heating surface, at 200 percent rating. With oil fuel, the overall boiler and furnace efficiency was 68 percent as determined during a 6½-hr. test. This installation was re-set and 200 sq. ft. of wall surface added, arranged as described above. A second test was made over a period of 7½ hours during which time the load was 240 percent of normal, with an efficiency of 80.6 percent. This is an increase of 12.6 percent over the original installed setting.

In another plant a very careful test was made of a battery of 6 of these boilers over a period of 4 days. The load carried was 352 percent of the normal rating, based on 150 hp. per boiler. Burning 1575 B.t.u. gas, an overall efficiency of 77.6 percent was obtained.

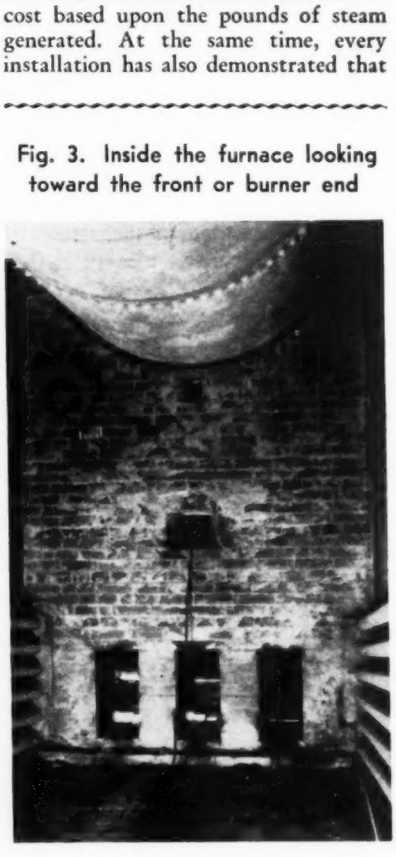
A cost comparison between the conventional horizontal return tubular unit and similar boilers equipped with water walls is available in the case of a refinery requiring replacement of some of its boiler facilities. The requirement was for 900 additional boiler hp. at the maximum boiler rating. Two propositions were considered, the one consisting of four 150-hp. horizontal return tubular boilers in 5-ft. settings as against two 150-hp. horizontal return tubular boilers set 8 ft. high and fitted with water walls. The cost figures for the two installations follows:

	No water walls	*Water walls*
No. of 150-lb., 150-hp. boilers	4	2
	Dollars	*Dollars*
Boilers with smoke box extentions, stacks, supporting steel, guy lines and trimmings	9450	6750
Angles, tie-rods, etc., for setting	398	219
Water walls	.....	2740
Hauling and erection	1500	1050
Brickwork	5760	3000
Burners	600	600
Foundation and deadmen	1275	750
Piping	1125	1020
Air-cooled floor	.....	419
Painting	187	114
Material (miscellaneous)	500	300
Insulation	300	213
Testing and preliminary operation	100	75
Insurance	250	175
Superintendence	450	450
Raising boiler house roof	269	181
Removing old boiler	644	530
Total	$22,808	$18,586
Cost/normal rating 600 and 300 b. hp., respectively	$38.00	$61.90
Cost/maximum rating 900 b. hp.	$25.40	$20.60

Based upon the pounds of steam generated per dollar invested, the water wall units were installed, and they have operated with complete success for the last four years.

Experience with these horizontal return tubular boilers equipped with water walls has proved to the satisfaction of the writer that they are superior to the conventional boilers in first cost based upon the pounds of steam generated. At the same time, every installation has also demonstrated that

Fig. 3. Inside the furnace looking toward the front or burner end



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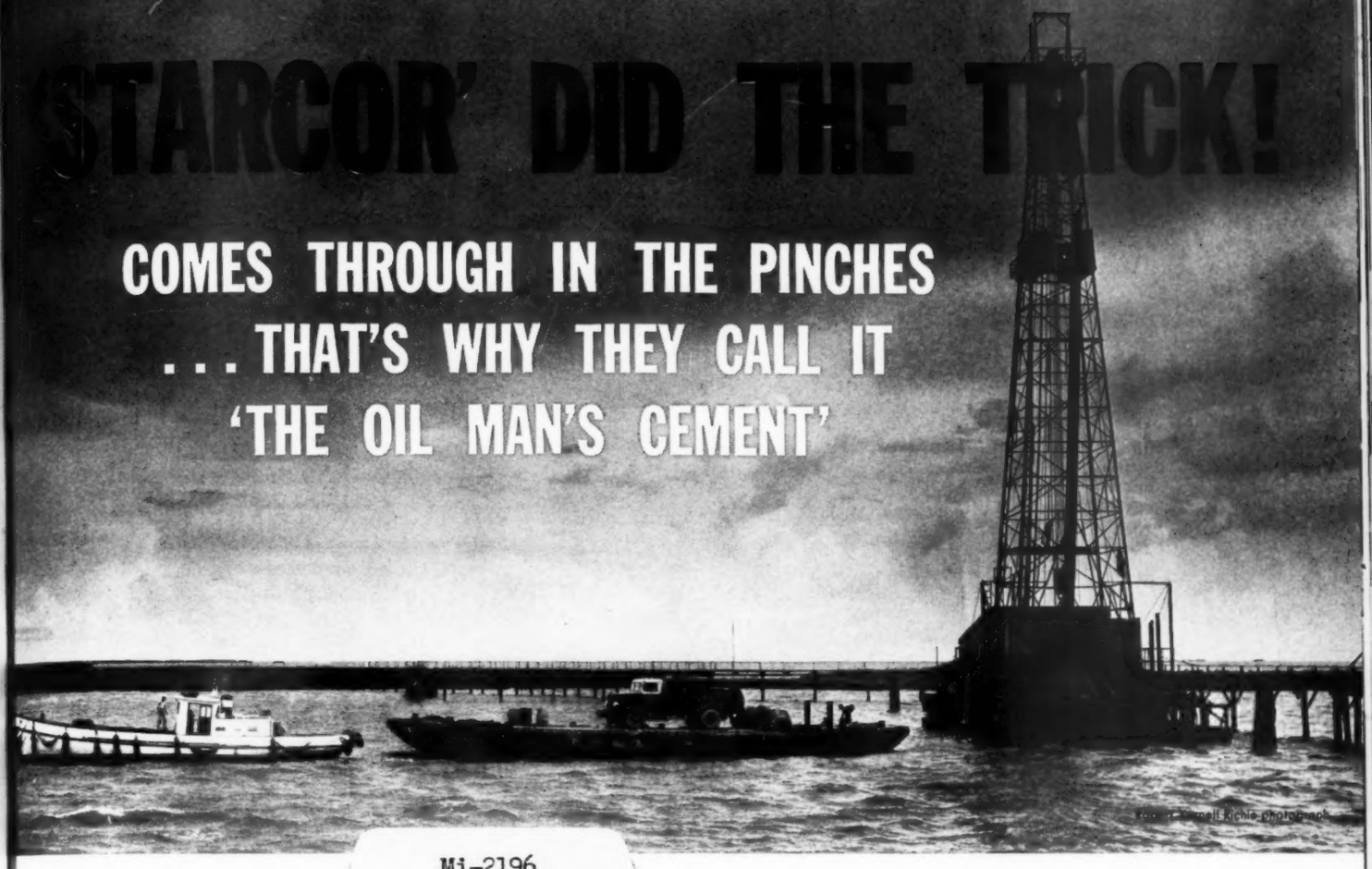

Mi-2196

FIELD: Lake Pelto, Louisiana
TYPE OF JOB: Casing; 7" O.D., 9-5/8" hole
DEPTH OF WELL: 5,500 feet
MAX. TEMP.: 150° F.
SLURRY WEIGHT: 16 lbs. per gal.
CEMENT USED: 'Starcor' - 400 sacks
MIXING TIME: 18 minutes
PUMPING-DOWN TIME: 27 minutes
MAX. PUMP. PRESSURE: 1800 lbs.
REMARKS: Mud weight, 10 lbs. per gallon; circulation broke at 900 lbs; well was circulated 1 hr. 20 min. prior to cementing... Another successful 'Starcor' job under unusual and difficult conditions.

SCATTERED over Terrebonne Bay, in Iberia Parish, La., are a number of domes, all producing oil. The wells are not very deep, but formations are so soft that holes are almost always crooked. This combination produced plenty of grief—until they switched to 'Starcor'. 'Starcor' did the trick, like the Oil Man's cement that it is. See typical job-log, at left.

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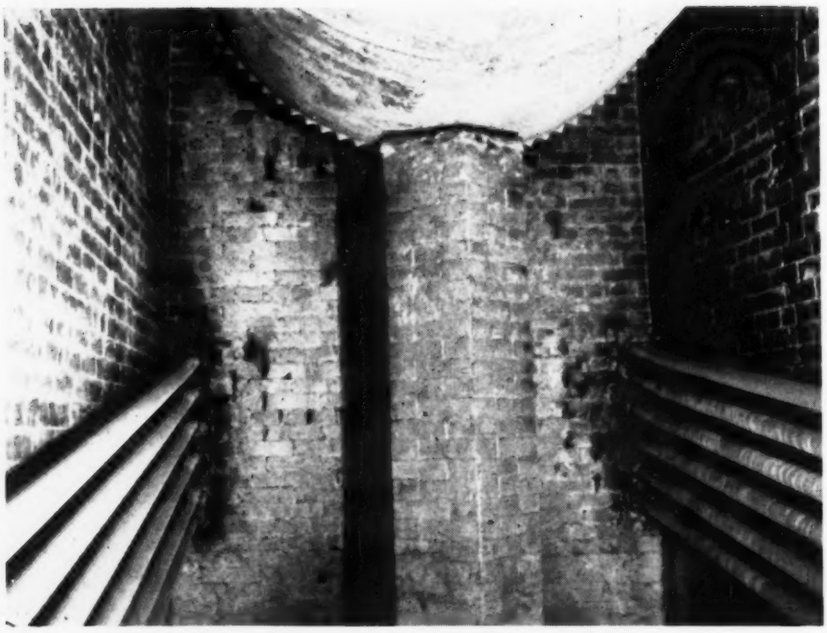


Fig. 4. In this rear view of the furnace the 9-deg. inclination of the water-wall tubes is clearly shown

the upkeep is less by reason of the lower brick-wall temperatures, and that it is practically impossible to damage the setting or boiler with overload conditions. Every installation has further demonstrated that less scale is formed in the water walls than on the shell and tubes of the boiler itself. This is undoubtedly due to the high tube velocities as contrasted with relatively low velocities within the boiler shell. Even with scale-forming waters the removal of such deposits from the water walls is a comparatively simple matter as compared to the work involved in scaling the boiler surfaces. As the cost of foundations and brickwork is somewhat of the same order for both types of boilers, the salvage value of either is the same. When the unit has been operated continuously at overloads in excess of 125 percent, the water-wall unit will have the higher salvage value. Regardless of the basis of comparison the water wall unit will generate more steam per dollar of capital investment.

P 670.2

Chart for Estimating Contents of Horizontal Cylindrical Tank

By

W. F. SCHAPHORST

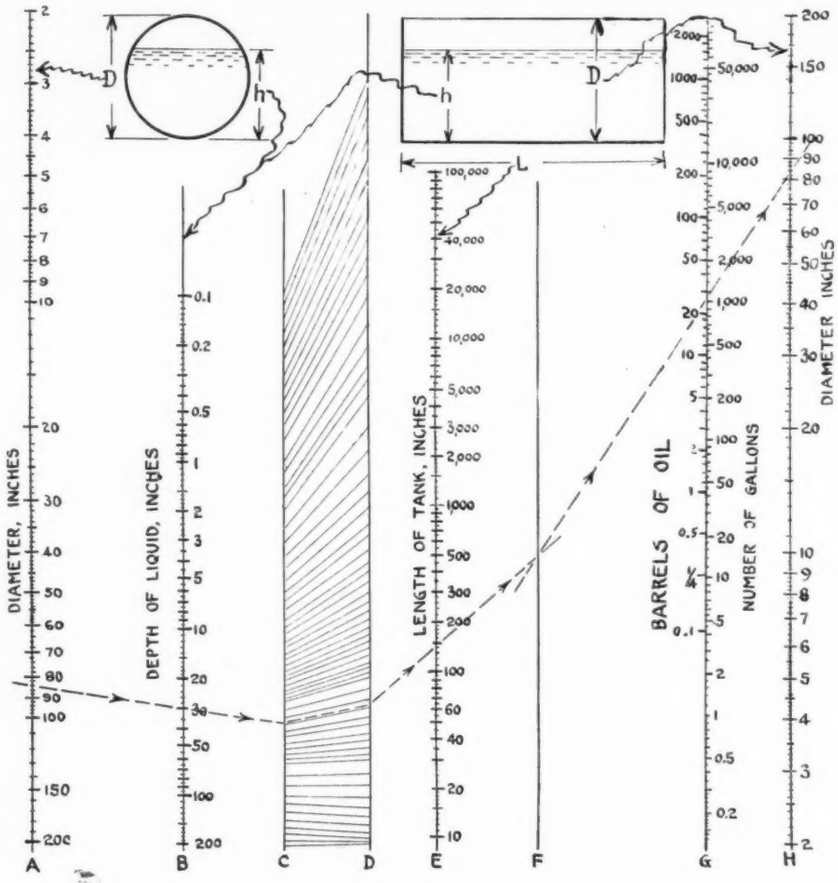
THE accompanying alignment chart offers a convenient means of estimating the contents of a horizontal cylindrical tank.

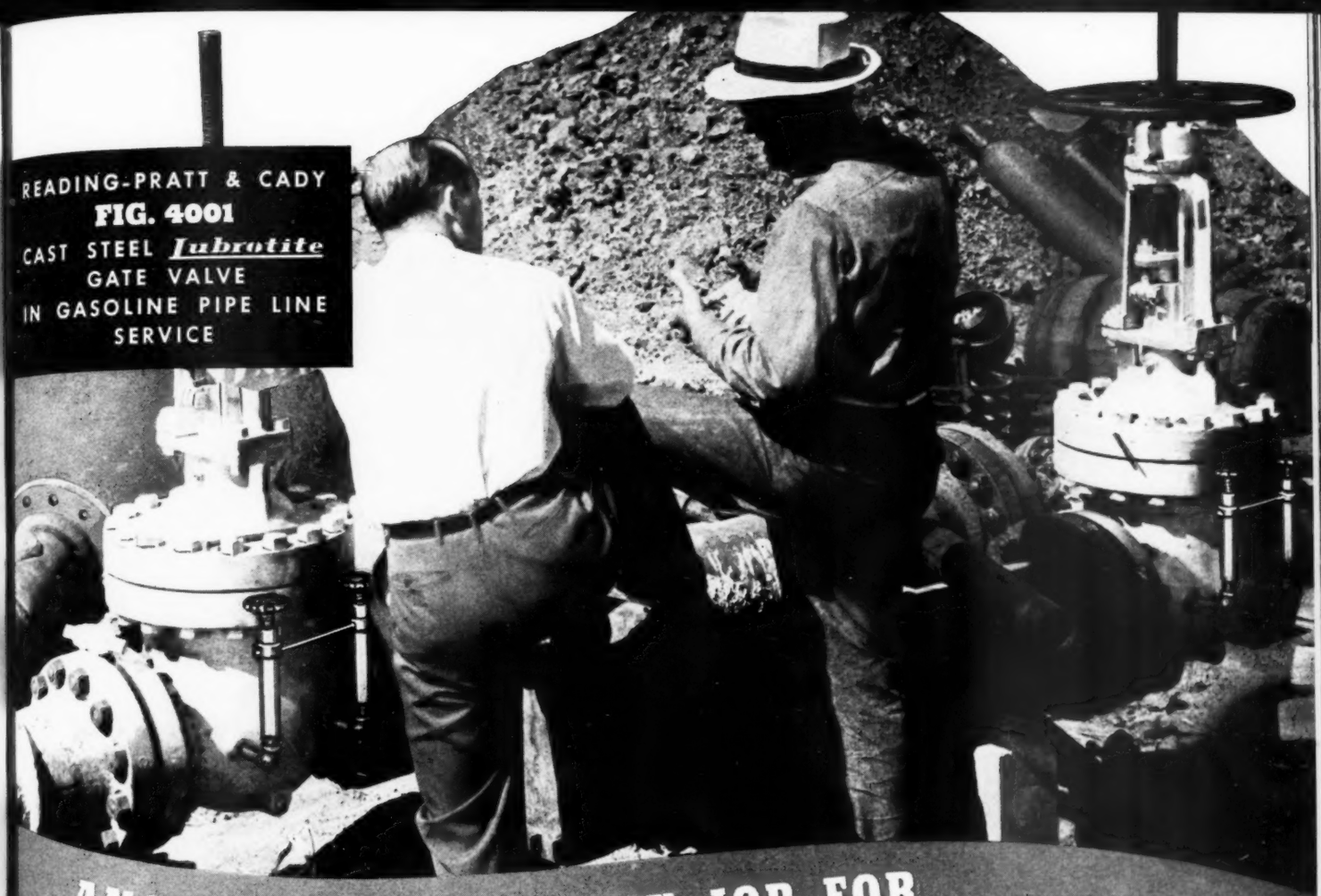
Example: How many bbl. of oil in a tank whose diameter is 84 in., depth of liquid 30 in., and whose length is 142 in.?

Use the chart in this way:

Run a straight line through the 84 in column A, and the 30 in column B, and locate the intersection with column C. By means of the eye follow the radiating "guide lines" to column D, locating a second point of intersection. From this latter intersection run through the 142, column E, and locate the point of intersection in column F. Then from this point run over to the 84, column H, and the intersection in column G tells that the tank contains 25 bbl. of oil, or 1050 gal.

As will be noted, the figures on the left side of column G give the results in barrels of oil, whereas the figures on the right side of that same column give the results in gallons.





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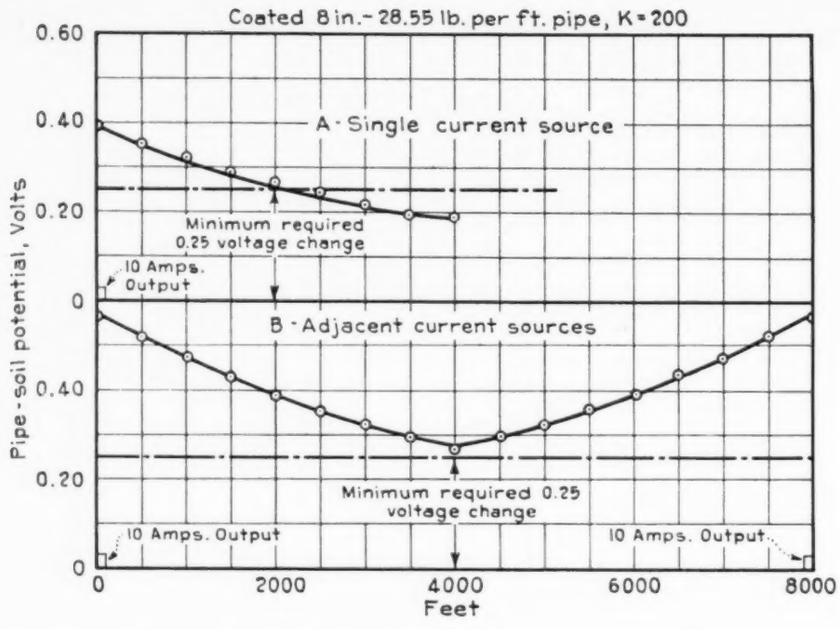

Fig. 1. Effect of single and multiple current sources on pipe-soil potentials

By
WALTER F. ROGERS
Gulf Oil Corporation

Method of Designing Cathodic Protection Installations

Design calculations can be made with equal accuracy for coated or bare lines—ground beds of practical size are usually limited to 400 ft. of 6-in. junk pipe, giving maximum life of about four years

THE relationships developed in previous articles* may be used to design cathodic protection systems. These systems are divided into two classes of pipe. The first is well-coated pipe and the second is poorly coated or bare pipe.

A. Well-coated pipe. It is generally accepted that a potential of 0.80 v. will give protection to well-coated pipe. This is normally a voltage increase of 0.25 v. in excess of the unprotected potential. Few corrosive soils have a resistance of more than 2000 ohm-cm. or 66 ohm-ft. Substituting in the following equation:

$$R = \rho \log_e 4 = 0.21\rho \quad . \quad . \quad . \quad . \quad (1)$$

R is equivalent to $0.21 \times 66 = 13.9$ ohms resistance for the soil annulus. If a potential of 0.25 v. is applied across this then the current flow is: $\frac{0.25}{13.9}$ = 0.018 amp. per lineal ft. As the area of 1 lineal ft. of 8-in. pipe is 2.26 sq. ft. this corresponds to $\frac{0.018}{2.26}$ = 0.008 amp. per sq. ft. This is the current density that will flow if a pin hole is present in the pipe coating. It has been shown that 0.008 amp. per sq. ft. will give 82.5 percent protection and this is the minimum that will be obtained if an impressed voltage of 0.25 v. is maintained on the coated pipe. This shows that if the value of K is determined by experiment for a coated pipe it may be used in the following equation:

$$V = -\sqrt{AK}\, I_o e^{-\mu x} \quad . \quad . \quad . \quad . \quad (2)$$

to determine the current source spacing to give protection to the pipe. For instance, suppose a 10-mi. section of well-coated 8-in. pipe is to be cathodically protected. A test would be made with a welding machine or storage battery and the values of V_o/V versus x plotted and K determined. Suppose the value of K is 200 ohm-ft. and a minimum potential increase of 0.20 v. is to be obtained. Table 1 has been compiled to show the value of pipe voltage change at different distances from one side of the drain for different current values. This table is obtained by substituting in equation (2) the known values of A and K and by varying I

*See articles by Walter F. Rogers appearing in September, October, and December, 1940, issues of *The Petroleum Engineer*.

WALTER F. ROGERS

was born April 3, 1905, at Tyler Texas—Graduated from Tyler High School in 1922—Graduated from University of Pittsburgh with degree of B.S. in chemical engineering in 1926—Received professional degree in chemical engineering from University of Pittsburgh in 1933—Began work for Gulf Refining Company at Port Arthur in 1926—Transferred to chemical laboratory of Gulf Oil Corporation, Houston, Texas, in 1927 where he is still employed—Has specialized in studies of corrosion of production and pipe-line equipment.

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TABLE 1
Pipe-soil potentials for 8-in. pipe
K = 200

Current, I,	Distance from current drain, x, ft.								
	500	1000	1500	2000	2500	3000	3500	4000	5000
amps.	0.909	0.827	0.751	0.684	0.622	0.565	0.514	0.468	0.387
5	0.176	0.160	0.147	0.132	0.121	0.109	0.099	0.091	0.075
10	0.352	0.320	0.294	0.264	0.241	0.218	0.197	0.181	0.149
15	0.528	0.480	0.441	0.396	0.362	0.327	0.296	0.272	0.224
20	0.704	0.640	0.588	0.528	0.482	0.436	0.394	0.362	0.298
25	0.880	0.800	0.735	0.660	0.603	0.545	0.493	0.453	0.373

Note: Figures in body of table are values of $e^{-\mu x}$.

$K = 200$

$A = 7.6 \times 10^{-6}$

$E = -\sqrt{AK}\, I_0 e^{-\mu x}$

Plain-end 8-in. pipe wt. = 28.55 lb. per ft.

$$\mu = \sqrt{\frac{A}{K}} = \sqrt{\frac{7.6 \times 10^{-6}}{200}} = 1.9 \times 10^{-4}$$

$$\sqrt{AK} = \sqrt{7.6 \times 10^{-6} \times 200} = 3.87 \times 10^{-2}$$

for a single value of x and then varying x for a single value of I. Suppose also that 50-amp. power sources are to be used, supplying 25 amp. each way from the drain. Reference to the table shows that 25 amp. will give a voltage change of 0.373 v. at a distance of 5000 ft. from the drain. The table is not extensive enough so it is necessary to substitute 0.20 for E, the values of A and K, 25 for I_0, and solve for $e^{-\mu x}$. This gives x = 8263 ft. Thus a 50-amp. current flow from the center of the 10-mi. section of pipe would protect 8263 ft. each way or a total of 3.13 mi. of pipe. Additional units then are required for the remaining 6.87 mi. of pipe. Referring to equation (3):

$$I = I_0 e^{-\mu x} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

the value of $e^{-\mu x}$ for x = 8263 ft. is 0.206. If $I_0 = 25$, the current in the pipe at this distance from the anode is 5.15 amp. This is the quantity of current that collects on the pipe outside the protected zone of 8263 ft. and is more or less wasted current resulting in partial protection beyond 8263 ft. If a second power source is placed 16,526 ft. from the first then these 5.15 amp. from each unit will be "squeezed back" over the 8263 ft. and the pipe potential changed accordingly. This amounts to the same effect as if the power source was increased in direct proportion to the current squeezed back. In this case the potential at a distance of 8263 ft. from the drain becomes $0.20 \times \frac{25.0 + 5.15}{25} = 0.241$ v.

The adjacent power sources may then be moved apart slightly and the desired potential of 0.20 v. obtained farther than 8263 ft. from each source. This distance may be calculated roughly by substituting in equation (2) $I_0 = 30.15$, the value of A and K, V = 0.20, and solve for the new x. This gives a value of 9300 ft. or 1.76 mi. The final design would call for 3 units: a 50-amp. unit 1.56 mi. from each end of the 10-mi. line thus giving a minimum of 0.20 v. at the ends and one unit in the center of the line, which will be 3.44 mi. from each of the adjacent units and will give a minimum potential between 0.20 and 0.24 v. Fig. 1 shows the general shape of the curves $V = -\sqrt{AK}\, I_0 e^{-\mu x}$ for a coated 8-in. pipe for which K = 200, A = 7.6 x 10^{-6} ohms per ft. with both one and two power sources of 10 amp. on each side of the drain.

B. Bare or poorly coated pipe. Design calculations are equally possible for bare pipe as for well-coated pipe. In this case current density values are the criterion rather than pipe-soil potentials. The data show that 0.004 amp. per sq. ft. will give 75 percent protection to bare pipe in corrosive soils. The data have also shown that the soil annulus resistance, R, in ohms can be used in place of K as experimentally determined in the field. The average value of ρ for most soil is 1500 ohm-cm. or 50 ohm-ft. although this may drop to 500 ohm-cm. or 16 ohm-ft. in swampy locations. Suppose it is desired to protect 10 mi. of bare 8-in. pipe in a soil of 50 ohm-ft. resistivity. R then equals $50 \times 0.21 = 10$ ohms. Table 2 shows the pipe potential change at different distances from the drain for different values of current. It also gives the values of $e^{-\mu x}$ for different distances from x. These are used to calculate the current pick-up of the pipe. A current density of 0.004 amp. per sq. ft. for 8-in. pipe is equal to approximately 50 amp. per mile. With this value of current (25 amp. each way from the drain) the average current pick-up for each increment of 500 ft. is calculated. This is shown in Table 3.

This table shows that the minimum required pick-up of 0.004 amp. per sq. ft. is obtained somewhere between 1000 and 1500 ft. from the drain. The current in the pipe at 1500 ft. from the drain is 6.8 amp. If the power units are applied 3000 ft. apart then the new average current pick-up between 1000 to 1500 ft. from the drain or 1250 ft. is:

$$\frac{25 + 6.8}{25} \times 0.0033 = 0.0042 \text{ amp.}$$

The power units may then be placed at regular intervals of 2980 ft. apart except at th ends where they will be 1000 ft. from each end. The total design would then call for eighteen 50-amp. units spaced as noted above. It will be noted that this results in average current pick-up values from 0.0042 to 0.0088 amp. per sq. ft., thus assuring that all the pipe receives more current than the 0.004 amp. per sq. ft. for 75 percent protection. The design can be worked out for different dis-

TABLE 2
Pipe-soil potentials for 8-in. pipe
K = 10

Current, I,	Distance from current drain, x, ft.							
	250	500	1000	1500	2000	2500	3000	3500
amp.	0.808	0.644	0.419	0.270	0.175	0.114	0.074	0.048
5	.....	0.028	0.018	0.012	0.007	0.005	0.003	0.002
10	.....	0.056	0.036	0.023	0.015	0.010	0.006	0.004
15	.....	0.084	0.054	0.035	0.022	0.015	0.009	0.006
20	.....	0.112	0.073	0.047	0.035	0.020	0.012	0.008
25	.....	0.140	0.091	0.059	0.042	0.025	0.015	0.010

Note: Figures in body of table are values $e^{-\mu x}$.

$K = 10$

$A = 7.6 \times 10^{-6}$

$E = \sqrt{AK}\, I_0 e^{-\mu x}$

$$\mu = \sqrt{\frac{A}{K}} = \sqrt{7.6 \times 10^{-6}} = 0.87 \times 10^{-3}$$

$$\sqrt{AK} = \sqrt{7.6 \times 10^{-6} \times 10} = 8.7 \times 10^{-3}$$

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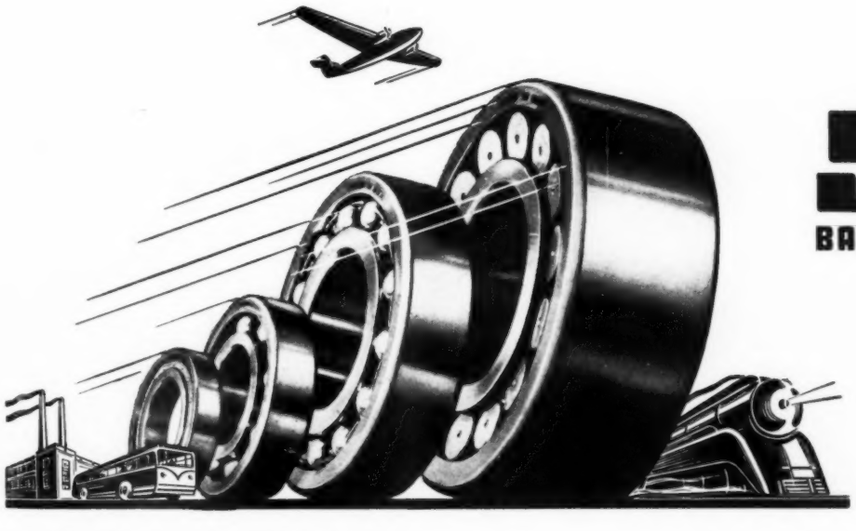

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TABLE 3
Current density collection by bare pipe

Distance from drain, ft.	$e^{-\mu x}$	Current in pipe, amp.	Average current pick-up per sq. ft. for each section
0	1.00	25	zero
250	0.808	20	0.0088
500	0.644	16.1	0.0068
1000	0.419	10.5	0.0049
1500	0.270	6.8	0.0033
2000	0.175	4.4	0.0021

tances required for different sized power units.

Ground Beds

The ground bed exercises a very important place in cathodic protection schemes. In general it must fill two functions satisfactorily: (1) to dissipate the current properly without too frequent replacement of the ground-bed material and (2) to have a low electrical resistance. Junk steel pipe is the most common form of ground-bed material. Assuming 100 percent current efficiency the amount of steel consumed per amp.-yr. is 20.09 lb. The current dissipated per ground bed usually varies from 50 and 100 amp. If it is 100 amp. then 2009 lb. of pipe metal is used per year or if the figure of 19.5 lb. per ft. of 6-in. pipe is used this amounts to 103 ft. of pipe per year. It is usually not found convenient to put more than 400 ft. of pipe in a ground bed and this limits its life to 4 years.

The resistance of the ground bed must be kept as low as possible in order to reduce current costs. The problem then becomes one of arranging 400 ft. of 6-in. pipe to give a minimum resistance. Some tests were made to determine how the resistance of a vertical ground bed would vary with depth of burial of the pipe. Table 4 gives the results of one test using 6-in. pipe. The data have also been plotted in Fig. 2. It will be noticed that the points fall on a straight line showing that the decrease of resistance with increasing depth of pipe is a logarithmic function. This means that the first few feet of pipe used give a much greater decrease in resistance than do the last few feet and doubling the length of buried pipe does not double half the resistance.

A second test was made to determine the effect of spacing between the pipes on the resistance. In this case 6-in. diameter pipes were used, being buried in vertical holes 5 ft. 7 in. in depth. Two of these pipes were used in each test. The only variable was the distance between the pipes. The data are listed in Table 5.

TABLE 4
Vertical depth of burial vs. resistance

Depth, ft.	resistance, ohms
2	1.00
4	0.76
5'7"	0.59
8	0.50
10	0.44
12	0.40
14	0.37

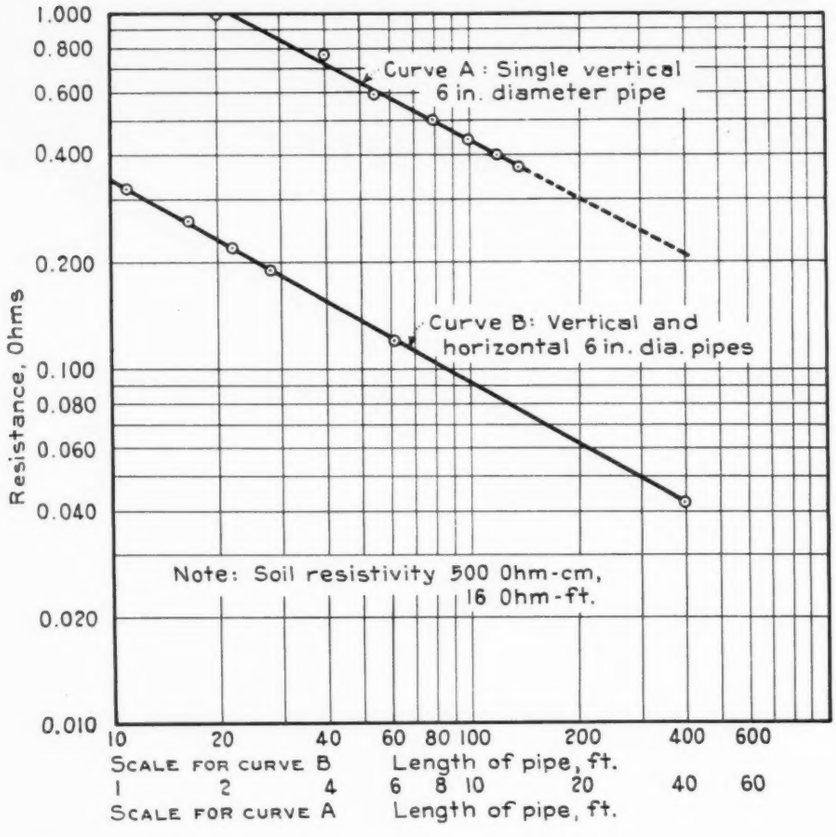
These data show that no practical change in resistance from separating the pipes occurred over a spacing from 20 to 200 ft. The increased resistance shown by the 180- and 200-ft. spacings is probably the result of a soil with a higher resistance than that found as far as 160 ft. distant from the stationary pipe. Thus nothing is to be obtained by separating pipes by any distance between 20 to 200 ft.

A third test was made, which was really a check of the first test, when different numbers of vertical pipes were each buried 5 ft. 7 in. in the ground. In each case the spacing varied from 20 to 80 ft. This spacing is of no importance as shown by test 2. In all, 11 such units were buried in combinations of 2, 3, 4, 5, and 11 pipes. This can be considered the same as pipe buried horizontally. The data obtained are given in Table 6. The resistance for the 400 ft. of pipe was obtained from ground beds of this size buried horizontally 18 in. underground in this same soil and used for the final ground beds. The data are plotted in Fig. 2. Again it will be noted that the points fall on a straight line. This means that in this particular soil the curve may be extrapolated to show the quantity of pipe required for any given ground-bed resistance. The fact that the 400 ft. of pipe was arranged as two 200-ft. sections on 20-ft. centers did not affect the value of the resistance as given by the curve.

These data show that little is to be gained in reduced resistance by increasing the quantity of pipe over that desired to last a given length of time, i.e., unless only a few feet of pipe were originally desired to be used. It is of further interest to note that the slopes of the two curves in Fig. 2 are identical. In other words, it does not matter whether the pipe is buried vertically or horizontally so long as the soil conditions are the same. It will be noted that a final resistance of 0.042 ohms was obtained for a 400-ft. ground bed. This desirable feature was largely the result of the soil being swampy (saturated with water at all times) and having a resistivity of approximately 500 ohm-cm. or 16 ohm-ft.

In general if a ground bed can be reduced to 0.10 ohms a satisfactory value has been obtained. This cannot

Fig. 2. Relationship of length of pipe in ground bed to resistance



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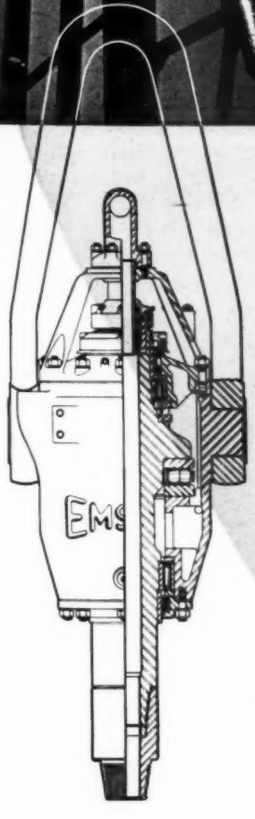

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TABLE 5
Effect of spacing on resistance between pipes

Number of 6-in. pipes	Spacing, ft.	Resistance, ohms
6 and 11	200	0.40
6 and 10	180	0.38
6 and 9	160	0.36
6 and 8	140	0.36
6 and 7	120	0.34
6 and 1	100	0.31
6 and 2	80	0.32
6 and 3	60	0.34
6 and 4	40	0.34
6 and 5	20	0.34

be obtained with 400 ft. of 6-in. diameter pipe in most soils that have a resistance at saturation of approximately 2000 ohm-cm. or better. The question then arises as to the best method of proceeding to get the desired 0.1 ohms resistance. The length being fixed, the two remaining variables are the pipe diameter and the soil resistance. The effect of changing the pipe diameter may be calculated from the radial formula: $R = \frac{\rho}{2\pi L} \log_e \frac{r_2}{r_1}$ or the resistance is decreased in the same proportion as the logarithms of the final and original diameters. This is a slow way to decrease the resistance and is of little practical value in changing from 4-in. to 8-in. diameters. The resistance of the ground bed is, however, directly proportional to the soil resistance and this is the most satisfactory value to change. When the soil resistivity is less than 1000 ohm-cm. (32 ohm-ft.), and the soil is wet at all times it is not necessary to use salt to get a resistance of 0.10 ohms with 400 ft. of 6-in. pipe. When the soil resistance is greater than this it is necessary to salt the ground bed. Calcium chloride is used for the salting medium because it is both highly ionized and will take moisture from the air to keep the ground damp. The usual procedure is to dig 400 ft. of ditch 3 ft. wide and 3 ft. deep. Two tons of calcium chloride are then used to backfill the pipe in alternate layers of salt and soil. There should be no danger of losing the salt through rainfall unless there is excessive run-off. Most run-off water will not remove salt and any water that seeps into the ground will only carry the salt down with it and help to decrease the soil resistance. The resistance of one 50-ft. salted ground and a 50-ft. unsalted ground were measured frequently during a 20-months period to see if the salted ground bed increased in resistance. The data are:

Date	*Resistance unsalted ground (ohms)*	*Resistance salted ground (ohms)*
4-18-38	7.43	1.46
12-12-39	6.90	1.44

It will be noted that during this time the salted ground-bed resistance decreased slightly and also that its resistance was about 1/5 the resistance of the unsalted bed constructed of the same amount of pipe in the same soil.

It is seen that in general the length of pipe is fixed by the time the ground bed is to last. When the pipe length can be a variable the resistance decrease is proportional to the logarithm of the pipe length and the resistance for any given length of pipe can be determined by plotting the resistance for different lengths of pipe as shown in Fig. 2. When the resistance is to be decreased by increasing the pipe diameter the change in resistance can be calculated by the radial formula. It is advisable, however, to resort to salting when the desired ground resistance cannot be obtained with the soil in its normal condition or by varying the pipe length or diameter within economic limits.

Summary and Conclusions

The data obtained from an extensive investigation of cathodic protection phonomena have developed the following facts:

TABLE 6
Effect of pipe length on resistance

Length of pipe ft.	in.	Resistance, ohms
11	2	0.32
16	9	0.26
22	4	0.22
27	11	0.19
61	5	0.117
400	0	0.042

1st. Steel pipes buried in well-aerated soils have potentials approximating those of gaseous electrodes; as the soil becomes wetter with displacement of soil gases the potential shifts toward that of a ferrous electrode.

2nd. The seasonal change in pipe potential results in an increase of approximately 0.12 v. in going from summer to winter conditions.

3rd. Bare pipes in wet soils develop hydrogen "build-up" potentials to a much greater extent than do pipes in well-aerated soils.

4th. A current density of 0.004 amp. per sq. ft. will give 75 percent protection to bare pipe buried in corrosive soil.

5th. A total potential of 0.80 v. measured to a copper sulphate electrode will give complete protection to a well-coated pipe.

6th. A mathematical relation has been developed that enables calculation of either current "pick-up" for bare pipe or pipe-soil potentials for well-coated pipe.

7th. Ground beds should be well salted to give a low resistance and decrease power costs unless the soil resistance is less than 1000 ohm-cm. without salting.

Acknowledgment

The writer wishes to thank the Executive Department of the Gulf Oil Corporation for permission to publish this article.

P 759.

Petroleum Synthesis Gives New Source for Glycerine

GLYCERINE, used in food, cosmetics, cigarettes, varnishes, lacquers, cellophane, resins, and, of course, nitroglycerine and dynamite, is the newest important industrial chemical to be produced synthetically, on a commercial scale, from petroleum.

Normal U. S. peace-time consumption of glycerine in these and scores of other uses amounts to well over 100,000,000 lb. per year, and in wartime its vital importance in the manufacture of explosives tremendously expands this demand. Announcement of the production of commercially pure glycerine, like the earlier reports of the manufacture of synthetic rubber and toluol, from petroleum, indicates the ability of the research chemist to eliminate industrial bottlenecks by chemical synthesis.

Discovery of the method used to synthesize glycerine from petroleum followed the research pattern that has resulted in the production of scores of other valuable industrial chemicals and synthetic products, including the super aviation fuels, from refinery gases that not long ago were burned.

The synthesis of glycerine, according to the process recently announced, begins with the separation of propylene from petroleum refinery gases. The propylene reacts with chlorine to form allyl chloride, from which allyl alcohol readily is made, and the allyl alcohol then is converted into glycerine. Both the allyl chloride and the allyl alcohol are themselves important as industrial chemicals, and there are reported to be dozens of other substances that can be made by minor variations in the glycerine process.

Basic Considerations In Refinery Piping Design

Viscosity and gravity effects are reviewed—the importance of maintaining viscous rather than turbulent flow is stressed—more attention to correct piping design is urged

By

R. G. LOVELL

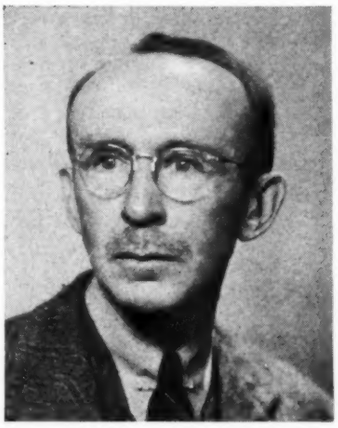
Development Engineer, Hancock Oil Company of California

THE approach to the subject of efficient refinery piping must be made from a different angle from that of a problem in which a system of lines is designed to transport crude oil or its products for considerable distances. There is just one point of similarity striven for in both jobs and that is efficiency. Efficiency does not, necessarily, mean perfection either of materials or methods. Let's define efficiency as we do the unit of work—the horsepower. If we understand the latter to mean 33,000 ft-lb. per min., then why not say that the unit of efficiency will be the amount of work in horsepower done per dollar of cost per unit of time?

Subjecting the two classes of piping problems to analysis with this in mind anyone can readily see that they begin to diverge right from the beginning. A system of gathering lines and a main trunk line constructed to transport crude oil from a field to a refinery over even a moderate distance is likely to cost, with pumps included, say, $500,000. One percent of this sum spent for intelligent and careful engineering is by no means excessive as it is likely to result in a definite increase in the value of this proposed efficiency number—hp./$/min.—or, conversely, a decrease in $/hp./min. The allocation of 1 percent of such appropriation for engineering and the time required to make the study intelligently are generally considered to be justified because of the relatively large capital sum to be invested and the long period of time over which the system is expected to operate under more or less standard conditions. A four-place decimal part of a dollar saved per barrel of crude handled per day becomes important money when multiplied by the total number of barrels per day.

Applying the Efficiency Number to Refinery Piping

A sense of reality compels the admission that, in many cases, the only time that a system of refinery piping receives careful engineering analysis and application of an efficiency number is when the plant is in the design stage. Even then it is not generally given consideration worthy of its importance and money-saving potentialities. There always have been three reasons for this lack of consideration: First, a feeling, justified by experience, that operating conditions in a refinery change so often that such consideration would not be warranted; second, the thought that, because of the relatively small difference in cost of the individual parts, or even of the whole, of a section of piping between units, as well as the difference in operating costs, careful consideration is not worthwhile, and third, the idea—also justified by past standards—that the calculations involved in such planning are too complicated and too involved for the average busy refinery man to undertake.



R. G. LOVELL

received his academic training in New York and served several of the larger mining and milling companies of New Mexico, Arizona, and the Republic of Mexico as power engineer and master mechanic from 1908 to 1917, then saw military service in the engineering corps until 1919—Returning from the war he became affiliated with the oil refining industry, first wih Standard Oil Company of California as refinery construction engineer and later with a foreign company—Later he was made assistant to the chief engineer of Pan American Petroleum and Transport Company for the construction of their California processing properties—He has been with The Hancock Oil Company of California since that time—Lovell is the senior instructor of the class in practical peroleum refining, which he organized some six years ago, for the Trade Extension Division of the Long Beach High Schools—The class is attended by employees of the many companies operating in the Southern California fields.

The purpose of this and subsequent articles is to nullify, or at least weaken, all three of these reasons. The idea will not be so much the development of new methods as it will be to interpret, in a simple way, methods already well-known and found by experience to be sound. No theory is worthy the name unless it can be put into practice—otherwise it is just a notion—and no practice is practical unless it conforms to fundamental theory. To bring them together is simply a matter of finding a common language in which to express both.

Learning From the Mistakes of Others

If any of us had to depend entirely upon our own experiences to devise the best methods to use in piping a refinery we would be likely to spend a lifetime of wading through the same errors that others had made before us. And, as it is as important to know the wrong ways if one knows *why* they are wrong, as it is to know the best ways if one does *not know why* they are best, we will endeavor to point out the reasons for both the right and the wrong ways as we go along.

Certainly the simplest method will be to set up an actual job of piping a typical refinery of, say, 10,000 bbl. per day crude throughput. Each unit of the piping will be considered separately, beginning with the initial terminal of the flow sheet. For example, in considering the section of piping designed to transport crude from storage to primary charging pump, the requirements to be met are:

Low friction loss

Immunity from corrosion

Freedom from fitting leaks

Protection against strains due to tank movement.

Fixed conditions will be:

Crude of 25° A.P.I. gravity and 250 S.S.U. viscosity

Storage tank of 80,000 bbl. capacity

Distance between tank and pump —1000 ft.

To keep the loss-of-head-due-to-friction as low as practicable is obviously desirable to avoid loss of pump capacity and the hammering caused by vaporizing in the suction. The definition of that which is practicable is the same in this case as it is in any other—getting the most for our money. The friction loss will be governed by:

Specific gravity of the oil

Viscosity of the oil

Unit cross-sectional area of the line

Length of the line

Number and kind of fittings in the line

Difference in elevation between level of liquid in tank and pump suction

Volume of oil to be handled per unit of time.

Effect of Viscosity and Specific Gravity

There are innumerable definitions of viscosity, none of which seems to fit all its manifestations. We will use, therefore, the one that describes its effect upon a piping layout. In this case viscosity is a measure of resistance to flow.

There is no present need for a description of all the various scales used for indicating viscosity as the two in general use in this country will fulfill all our present purposes. These are the Saybolt Seconds Universal (S.S.U.) and the Saybolt Seconds Furol (S.S.F.). S.S.U. is used for all except heavy oils and S.S.F. units are used for these. Both are arbitrary scales and are determined by permitting 60 cc. of oil to pass through an orifice of standard and accurate dimension while at a constant and indicated temperature. The number of seconds required for the passage is the reading. The Furol scale was devised only to lessen the time of test by using a larger orifice. For all present purposes the factor of conversion from Furol to Universal or vice versa can be called 10 to 1. For example, an S.S.F. reading of 40 may be considered as 400 S.S.U.

Temperature-Viscosity-Gravity Relationship

The effect of temperature change upon the specific gravity of an oil and the result of the change in gravity upon the facility with which the oil flows through a line is not as thoroughly understood as it should be. If the effect of the temperature change were confined to the specific gravity (density) the problem would be simple, but viscosity also enters into the picture and, therefore, all three of these factors must be considered jointly. Fortunately, however, no one needs to make any involved calculation to arrive at a figure that represents this joint effect upon a piping problem. Tables, graphs, etc., are available that represent the results of careful tests and are adequate for the needs of a busy man. Nor is their interpretation difficult if one is conversant with the fundamentals.

As heat is added to an oil, causing its temperature to increase, the oil expands and, consequently, becomes less dense and weighs less per unit of volume. If viscosity were not a factor or if the fluid were of extremely low viscosity such as gasoline, water, or kerosine, then the flow through the line would be affected in one of two ways depending on the type of pumping unit being used. If a constant speed displacement type pump is used, wherein the volume being handled is entirely a function of the speed and bore, then, obviously, because a gallon of the fluid weighs less at higher temperature, less power is required to force it through the line. But the total volume having become greater the time required to pump a unit volume of it becomes longer and the net result in horsepower required remains practically the same.

If the pump is of centrifugal type, and is designed for a total discharge head greater than that offered by the fluid flowing through the discharge line, the situation is somewhat different. As the volume of liquid delivered to the pump becomes greater because of increased temperature, the pump accepts the increased quantity and puts it through the discharge line, but the total discharge head is no higher because of the lowered specific gravity.

Specific Gravity-Viscosity Relationship

To obtain a clear conception of the specific gravity-viscosity relationship requires a definition of a definition. The definition of viscosity as the unit of measurement of resistance to flow is correct only insofar as it defines the word. A more accurate description of the manner by which viscosity limits the flow is to say that it is *fluid friction*. And it will aid in the conception if one understands fluid friction to be, in many respects, the same as solid friction.

Two of the factors that govern the total friction caused by a shaft turning in its bearing are the weight of the shaft and the speed at which it is turning. Let the density of the oil be compared to the weight of the shaft and the velocity of flow relate to the r.p.m. of the shaft, and we have a simple way of looking at the specific gravity-viscosity relationship as it affects a piping problem. When the oil is heated, thereby decreasing its density or, in other words, lessening the pressure of one particle against the adjoining ones, the same result has been accomplished as if the shaft had been enlarged but a lighter material had been used to make it. The unit pressure per sq. in. of the shaft has become less but the total pressure remains the same. The pressure of one particle of the oil against the adjoining ones has been lessened but, as the volume has increased but still must be contained in the same area, no particular difference has been made in the friction load.

On the other hand, the effect of the increased temperature upon the *viscosity* is comparable to dressing-down a relatively rough metal surface on the shaft or bearing to a much smoother surface.

Regularity of These Relationships

Within certain more or less definite limits the changes in both viscosity and specific gravity with change in temperature proceed regularly. The amount in which a petroleum oil expands—its coefficient of expansion—is directly related to its specific gravity. For instance, a gasoline of 57° A.P.I. gravity (actual specific gravity of approximately 0.75) will expand nearly twice as much when its temperature is increased from 100° to 200°F. as will a heavy oil of 10° A.P.I. (sp. gr.=1). This will hold true for all petroleum oils regardless of the field whence they come, or their chemical structure, so long as this chemical structure is not changed by such a high temperature that vaporization or decomposition takes place. This qualification of the rule is to become pertinent when we discuss the piping in the cracking plant.

The *viscosity*-temperature relationship *is* affected by the nature of the oil and the field whence it came. This is true, not only when the oil is in crude state, but to a still greater extent in the intermediate and finished products, for certain simple reasons that will presently be brought out. The decrement in viscosity proceeds in regular

proportion with increment in temperature for any one oil but is not in arithmetic progression. The standard A.S.T.M. chart on which these relationships may be plotted shows the progression logarithmically. By means of such a chart one can forecast accurately the viscosity of a given oil at any temperature if he knows its viscosity at any two temperatures within the range from cloud point to vaporization.

The paraffinic crude oils depart from the rule at low temperatures more than the naphthenic because of the tendency of the former's wax content to solidify at low temperature.

Insofar as pipe work is concerned, the matter of greatest importance in this respect is the enormous change in viscosity of the bottoms product of a cracking plant. When the bottoms product from a crude distillation, having a viscosity at 14° A.P.I. of 125 S.S.F. at 122°F., is subjected to cracking conditions the bottoms product therefrom is found to be much lower in viscosity under equal conditions of temperature and gravity than a crude bottoms. An example of this can be cited by setting up a typical set of conditions. From a cracking plant charge stock of 14° A.P.I. one might have a cracked bottoms of 10°-12° A.P.I., depending upon the extent to which the cracking was carried. When this product is "cut back" to 14° A.P.I. with either straight-run or cracked gas oil, the viscosity is found to be considerably less than half that of straight-run bottoms of the same gravity.

In passing it will be well to note that this accounts for the greater combustion efficiency of a cracked fuel oil inasmuch as it atomizes easier and, consequently, makes a more intimate mixture with the air of combustion. The point of greatest pertinence right now, however, is the manner in which this lowered viscosity affects the pumpability of the oil. Later this will be developed in terms of dollars per unit of oil being pumped.

Viscous and Turbulent Flow

An understanding of the way in which a viscous oil flows in a line is vitally necessary to an understanding of some of the peculiarities to be found in the tabulations and graphs that are used in forecasting the results of varying flow conditions.

When a viscous oil is passing through a pipe, either by gravity or by an outside force, it does not travel as does a solid body. The flow is actually in the form of a multitude of concentric rings. The center or core is traveling faster than the ring next outside it and so on. The ring that is in contact with the wall of the pipe moves much slower than any of the interior rings. This is evidenced by observing that a stream of heavy oil issuing from the open end of a line is cone-shaped. This is a result of viscosity. Remembering that viscosity is a measure of friction and that total friction is a function of units of area, it is easy to see that each of these rings from the center out has greater circumferential area than the one next inside and, consequently, suffers more from the retarding effect of viscosity. The outside ring, being in contact with the more or less rough inside wall of the pipe, has a much higher retarding effect to overcome.

Even with smooth-walled pipe, the outside ring has markedly greater resistance to overcome simply because its outside surface is in contact with a stationary surface. This is analogous to starting an automobile in high gear from a standing stop. The friction between rear tires and roadway is destructive to tire surface. If, however, the car is already in second gear and traveling say, at 15 m.p.h., and you shift to high, accelerating at the same time to 20 m.p.h., little friction is developed.

The change from viscous, or streamline, flow to turbulent flow occurs when the velocity has become so high that the resultant retarding effect of viscosity becomes so great as to cause the rings, or layers, of fluid to turn over and mingle with each other. The result of this is a decided increase in friction loss. In moving oil in pipe lines, therefore, velocities high enough to cause turbulence are to be avoided when practicable. The reverse is true when heat exchange enters into the problem.

Other Influencing Factors

Refer now to the earlier part of this article where requirements to be met were enumerated under a typical set of conditions. Suction was to be taken from an 80,000-bbl. tank. This tank when full would have a liquid height of approximately 40 ft. We cannot take this into consideration when calculating the flow because the tank would seldom be full. We can call this full height a gift to be used when it exists.

Oil of 25° A.P.I. gravity has an actual specific gravity of approximately 0.9, which, multiplied by the pressure exerted by a column of water 1 ft. in height (0.434 lb. per sq. in.), gives us 0.39. The static pressure on the line, therefore, equals 40×0.39 or 15.6 lb. per sq. in. Consequently, no problem of pressure enters into the calculation of this unit of refinery piping. Conversely, the low pressure presents the opportunity of effecting a saving in friction loss by the use of larger-diameter, lightweight pipe. This does not, necessarily, imply use of the same size for the tank and pump valves. One should always keep in mind that friction loss is by unit of length of line. A reduction of diameter at a valve through which the distance is 1 ft. certainly is not going to add materially to the total friction loss in a line 1000 ft. in length. It is obviously advisable, therefore, to use a high-grade steel valve at the tank, even if of smaller size than the line, to insure against loss of contents of the tank from valve failure.

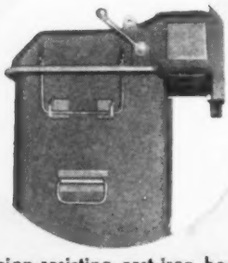
Protection Against Corrosion

To provide some degree of protection from corrosion of the line is only sound practice. The degree of this protection is a matter for consideration from the angle of dollars per unit of time or barrels of oil to be handled. When we discuss construction of the line the matter will be treated from this point of view. For the present it will suffice to direct the reader's attention to the necessity of studying the proposition jointly with that of the most economical size of pipe. Pipe wall thicknesses are often decided upon, not entirely because of pressure requirements, but also with the idea that the thicker pipe wall offers immunity for a longer period of time from line failures due to corrosion. To follow this idea too far can easily turn out to be very expensive.

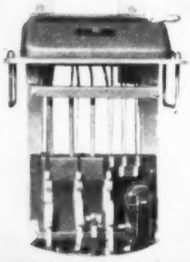
EDITOR'S NOTE: In another article to appear in an early issue, the writer will present the tables and graphs that have been found to be of the greatest value to him in making layouts of a single refinery line or of a complete refinery system of piping. The reader will be carried through each step of designing the line from crude storage to charging the pumps, using these tables and curves, and the practical viewpoint will be stressed throughout the discussion.

Announcing The NEW

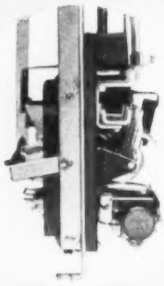
3 IMPORTANT FACTS ABOUT THIS G-E OIL-IMMERSED STARTER



The corrosion-resisting cast-iron head is designed for making conduit connections from top, bottom, or either side. Installation is easy, expense is low.



The starter can be furnished with operating parts six inches under oil. When thus arranged, it is suitable for installation in a hazardous gas location.



The circuit breaker can interrupt a short circuit of 10,000 amperes. The breaker and the magnetic switch are mounted back to back. This arrangement is compact and is better able to withstand the mechanical stresses that a short circuit on the line might cause.

EASY TO INSTALL

The CR7008 oil-immersed starter consists of a magnetic switch for motor starting and a circuit breaker for disconnecting and for short-circuit protection. They come to you in one "package," to be installed as a unit—saving you time, trouble, and expense.

This starter is designed for wall mounting. It needs only four bolts. The cast-iron head, a new feature, keeps the case from the wall and enables you to make rigid conduit connections from *top, bottom, or either side*. The incoming and outgoing terminals have solderless connectors. The control terminals are furnished with a binding screw. All this makes for easy wiring. Two stainless-steel tank holders provide a simple means for attaching the tank.

ASSURES LOW MAINTENANCE, DEPENDABLE SERVICE

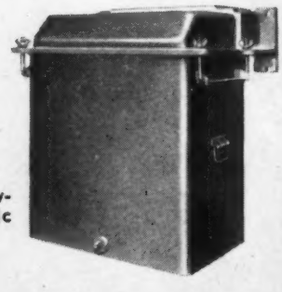
All operating parts, including the overload relays and the circuit breaker, are immersed in oil. Corrosive fumes cannot get at them. The cast-iron head, mentioned above, resists corrosive moisture that may condense on it. The case is of copper-bearing steel, painted with aluminum paint. The contactor tips are extra heavy and are reversible in the Size 2 and Size 3 starters, thus being good for twice the usual length of service. Flamenol wire, which is resistant to oil, is used thoroughout the switch in making connections.

EASY TO INSPECT

The operating devices are easily accessible. A special track arrangement on the inside of the tank facilitates moving the tank up and down. Hooks on which to hang the tank after it has been lowered are provided. You don't have to set the tank on the floor and run the risk of its being upset and spilling the oil.

THE G-E LINE OF OIL-IMMERSED CONTROL MEETS

Type C4, high-voltage, high interrupting capacity



Type CR7006, low-voltage magnetic starter

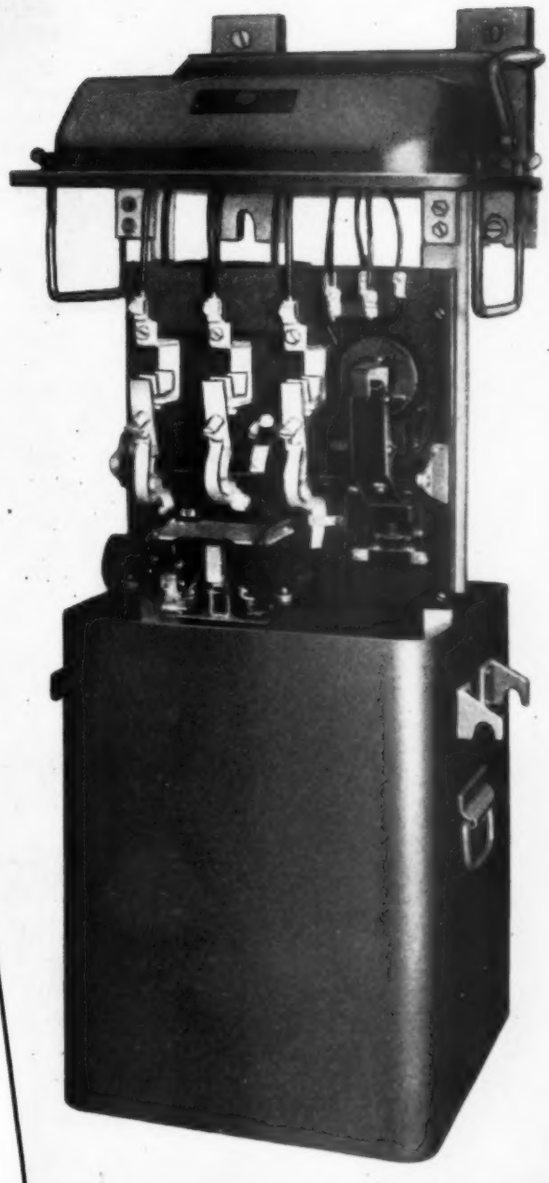
G-E OIL-IMMERSED COMBINATION STARTER

for Low-voltage Service

PROTECTS MEN AND EQUIPMENT

Thermal overload relays, specially designed for operation in oil, protect the motor against damage from excessive overloads. They are mounted with contacts at the bottom or side to prevent the possibility of oil sludge's interfering with their action. Undervoltage protection safeguards machines and operators from danger of unexpected restarting after a power interruption. The incoming terminals and the wires to the top of the circuit breaker are completely shielded so that an operator cannot make accidental contact with these live parts.

The new type of circuit breaker has a rating of 10,000 amperes and will interrupt short circuits up to that value. It is operated by means of a handle extending through the switch cover. The tank cannot be lowered unless this handle is in the "off" position, and power cannot be turned on until the tank is in place—an important safety feature.



HERE'S the oil-immersed control you've been asking for! This G-E CR7008 combination starter is now available for service with motors up to 30 hp at 220 volts, and 50 hp at 440 volts. It's packed with the features you want—new ones to meet the latest ideas and suggestions of operating men, old ones that have thoroughly proved themselves under actual operating conditions in refineries and chemical plants.

Decide now to install these new starters in your plant or refinery. Our nearest representative will be glad to go over your requirements with you. General Electric, Schenectady, N. Y.

ALL YOUR REQUIREMENTS!

Type R1AA, high-voltage, normal interrupting capacity

GENERAL ELECTRIC

GEA-4

Practical Application of Planned Optimum Rate Proration

Part 2 (Concluded)

By ALEC M. CROWELL

Director-Engineer, Arkansas Oil and Gas Commission

FOLLOWING the discovery of a new pool, reservoir pressure tests are conducted on representative wells by the engineers as development proceeds. These key wells are selected for their structural position and must be so spaced that the areally weighted reservoir pressure obtained will be representative for the pool as a whole. Once selected, these same wells remain as key wells during the life of the pool. After a shut-in period of not less than 24 hours, each well of the key well group is tested at regular intervals with standard subsurface pressure gauges.

The bottom-hole pressures obtained are then posted on a map at the points representing the well locations; the map is contoured in 50-lb. intervals and planimetered so that the areally weighted reservoir pressure may be arrived at. The individual pressures of the wells not tested are read from the map by interpolation.

Unnecessary Wells

To prevent waste and to avoid augmenting and accumulating the risks attendant in the drilling of an excessive number of wells, the development of all pools is upon a drilling unit basis. The "drilling unit" is the estimated maximum area that may be efficiently and economically drained by one well. The law fixes the maximum area for oil pools at 40 acres; consequently in most of the pools now operating under production control the drilling unit has been fixed at 40 acres.

Of 29 Arkansas oil fields now producing, some of them since 1920, there are 11 pools actively prorated and two operating under temporary rules. Twelve of these 13 have 40-acre units.

A photograph and biographical sketch of the writer can be found on page 37 of the December issue of *The Petroleum Engineer*, in connection with Part 1 of this article.

Along the edges of pools where the unit may be partly outside the limits of production, fractional units are drilled. For instance, if 30 acres were designated as the unit and a well drilled thereon, the allowable for that unit would be 141 bbl. daily if the allowable of a unit of like pressure and having 40 acres was 188 bbl. daily.

Determination of Optimum Production Rate

Briefly, changes in reservoir pressure and in gas-oil ratio determine the production quota fixed for any pool for a given period.

If, in a water-drive pool, a decline in reservoir pressure is registered for two consecutive periods, the quota for that pool is restricted until the pressure decline is arrested.

In the case of a gas-drive pool where pressure decline is a normal function of withdrawal of oil and gas, an abnormal acceleration of decline may result in the Commission further restricting gas-oil ratio allowances.

Very soon, in each oil pool, the most efficient rate of production can be determined within 10 or 15 percent of the optimum. As soon as this rate is determined, a top allowable is set, subject only to minor adjustment as additional units are brought into production.

Market Demand Factor

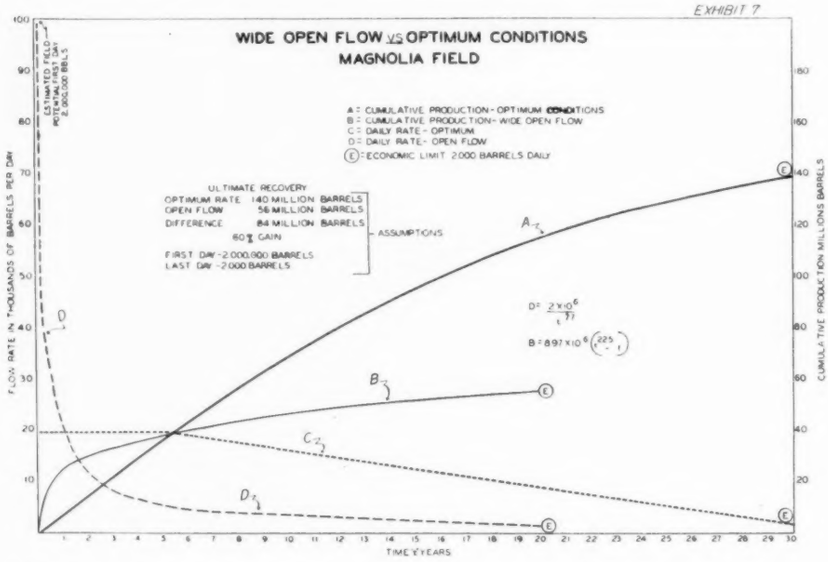
Under this system of fixing optimum rates of production, market demand plays only a secondary role. Inasmuch as the inefficient or unnecessary storing of oil is prohibited, it is impossible to exceed the bona fide market requirements for oil from the fields under control without violating the law.

To illustrate the success of this policy of optimum rate quota fixing, three facts[5] are at hand.

1. Out of nine million barrels of available storage, eight million barrels are now empty.
2. Stocks of all oils have been reduced appreciably since the advent of proration, irrespective of increasing production.
3. With pipe-line facilities amounting to 225,000 bbl. daily, only 70,000 bbl. of oil are being transported. (This is for all production including stripper wells).

At all times since the adoption of optimum rate quotas, the demand or market for oil from each pool has exceeded the normal efficient rate indicated for each pool. Adequate pipeline facilities are now and have been sufficient to transport the oil requested above the existent quota.

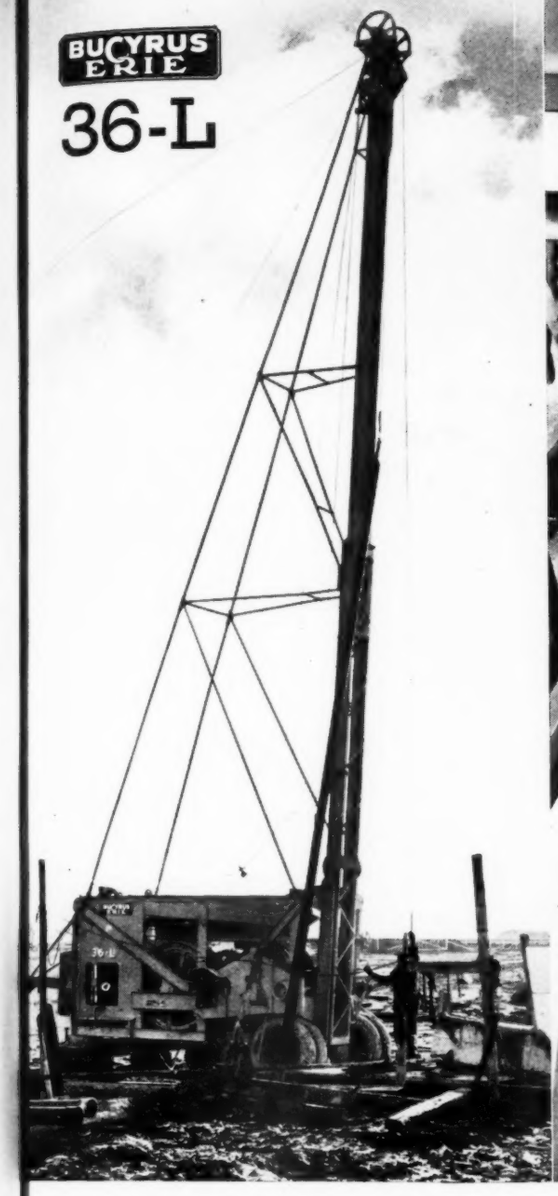
EXHIBIT 7

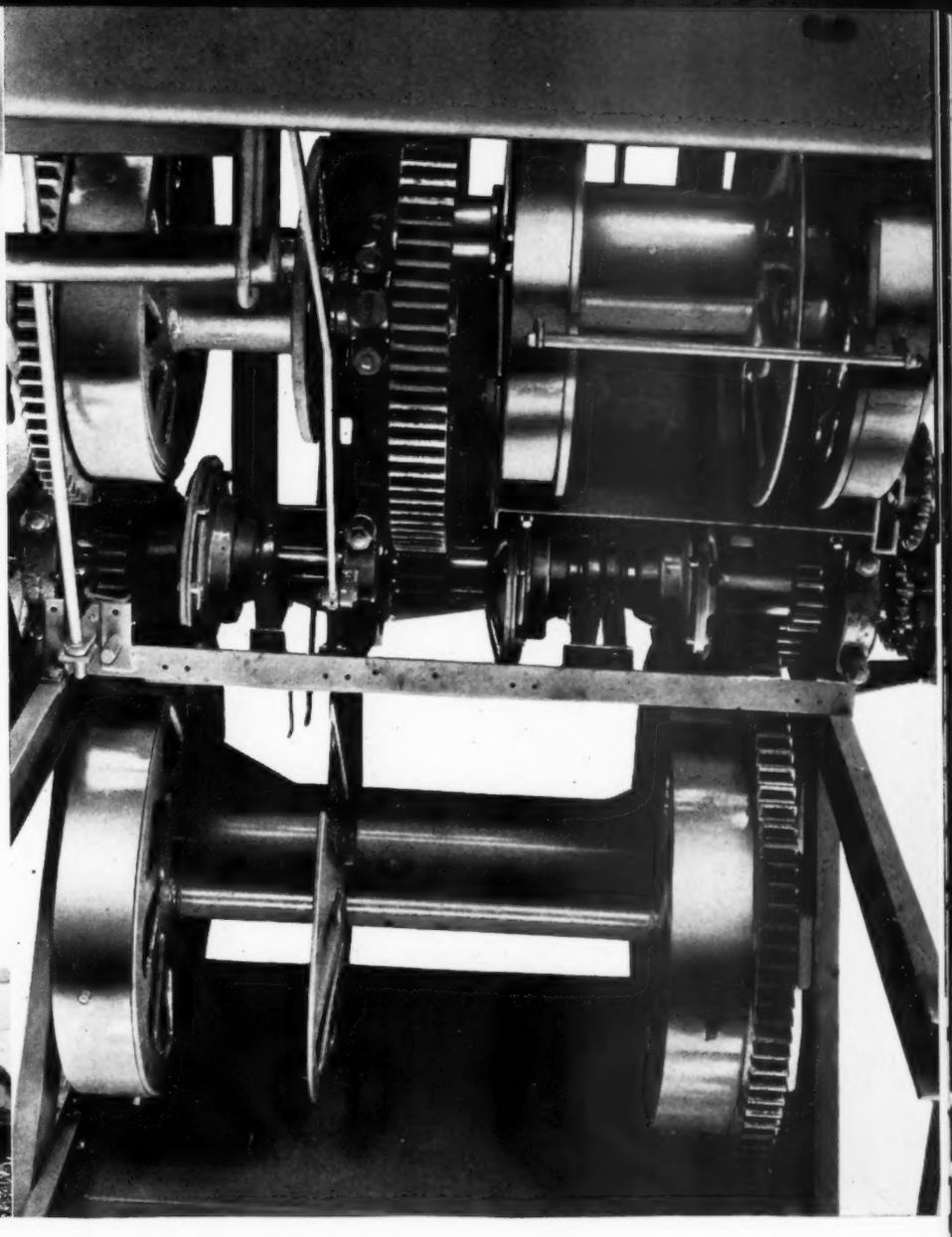

WIDE OPEN FLOW VS OPTIMUM CONDITIONS
MAGNOLIA FIELD
A = CUMULATIVE PRODUCTION - OPTIMUM CONDITIONS
B = CUMULATIVE PRODUCTION - WIDE OPEN FLOW
C = DAILY RATE - OPTIMUM
D = DAILY RATE - OPEN FLOW
E = ECONOMIC LIMIT 2000 BARRELS DAILY
ULTIMATE RECOVERY
OPTIMUM RATE 140 MILLION BARRELS
OPEN FLOW 56 MILLION BARRELS
DIFFERENCE 84 MILLION BARRELS
60% GAIN
ASSUMPTIONS
FIRST DAY - 2,000,900 BARRELS
LAST DAY - 2000 BARRELS
FLOW RATE IN THOUSANDS OF BARRELS PER DAY
CUMULATIVE PRODUCTION MILLIONS BARRELS
TIME IN YEARS

[5] "A Survey of the Oil and Gas Industry in Arkansas," prepared for the National Defense Council by Alec M. Crowell, August 1, 1940.

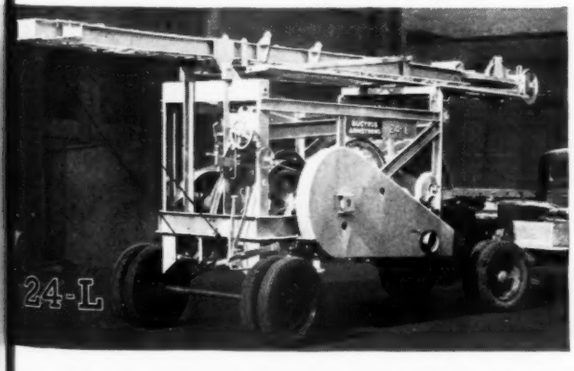
BUCYRUS ERIE

36-L





SPUDDING GOES MODERN



SMALLER COMPANIONS AVAILABLE

Other sizes, tailored to meet your requirements are also available. All spudders can be had with trailer mounting coming within hauling requirements of practically any highway. When moving, telescoping derrick and braces are folded together compactly with no loose pieces. Derrick can be set up in 20 minutes. Ask for a bulletin on the smaller spudders if you work shallow fields.

In the new Bucyrus-Erie big capacity, cost cutting, 36-L Spudder all unnecessary weight has been eliminated by compact modern design and use of modern special extra tough steels throughout. Rigid trussed box frame is electric welded; holds machinery in enduring alignment. Parts are held accurately in position, require little adjustment or maintenance.

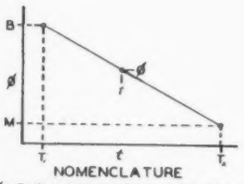
The 36-L can handle over 4,500 lbs. of tools in shallow holes or combined weight of 6,000 lbs. to 7,000 lbs. of tools and cable in deeper holes. It handles casing without shear poles; the powerful calf reel can lift to 30 tons on 6-part tackle over the derrick. The chain-driven sand reel will spool, without divider, 6,180′ of 9/16″ or 7,800′of ½″ wire sand line. Dual sand reel brakes, one at each end, are 36″ x 4″ lined with ½″ asbestos blocks and with equalizer for high speed bailing action. The bull reel is gear driven, free wheeling, with two speeds forward and one reverse, has big dual equalized brakes for accurate control. Spooling capacity without divider 6,950′ of ⅞″, 9,400′ of ¾″, 13,500′ of ⅝″ wire line. Hoisting capacity to 27,800 lbs. in low gear.

The 36-L can cut your costs. See for yourself . . . write for bulletin today.

BUCYRUS-ERIE COMPANY

SOUTH MILWAUKEE, WISCONSIN, U. S. A.

EXHIBIT NO. 8



NOMENCLATURE

ϕ—FLOW RATE—BBLS. PER DAY
t—TIME—DAYS
B—INITIAL "ϕ"—BBLS. PER DAY
M—FINAL "ϕ"—BBLS. PER DAY ECONOMIC LIMIT
T_i—INITIAL "t"
T_f—FINAL "t"
ZQ—CUMULATIVE RUNS—BBLS.

$$\text{SLOPE} = \frac{\text{LOG } M - \text{LOG } B}{\text{LOG } T_f - \text{LOG } T_i} = X$$

$$\frac{\text{LOG } \phi - \text{LOG } B}{\text{LOG } t - \text{LOG } T} = K \text{ (GENERAL FORMULA)}$$

$$\text{LOG } \phi - \text{LOG } B = K(\text{LOG } t - \text{LOG } T)$$

$$\text{LOG } \frac{\phi}{B} = K \text{ LOG } \frac{t}{T}$$

$$\frac{\phi}{B} = \left(\frac{t}{T}\right)^K \quad \text{OR} \quad \phi = \left(\frac{B}{T^K}\right) t^K$$

$$ZQ = \int_{T_i}^{T_f} \phi\, dt = \frac{B}{T^K} \int_{T_i}^{T_f} t^K\, dt = \left(\frac{B}{T^K}\right) \frac{t^{K+1}}{K+1} \Bigg]_{T_i}^{T_f}$$

WHEN $T_i = 1.0$ (THE FIRST DAY)

$$ZQ = \frac{B}{(K+1)} \left[t^{(K+1)} - 1\right]$$

MAGNOLIA FIELD

	DAILY PRODUCTION END OF YEAR BBLS	PRODUCTION BY YEAR BBLS
1.	21000	24000000
2.	12000	6000000
3.	9000	3000000
4.	7000	2500000
5.	6000	2500000
6.	5000	2000000
7.	4200	2000000
8.	3700	2000000
9.	3200	1500000
10.	2800	1500000
11.	2400	1000000
12.	2000	1000000
13.	2000	1000000
14.	2000	1000000
15.	2000	1000000
16.	2000	1000000
17.	2000	1000000
18.	2000	700000
19.	2000	700000
20.	2000	600000

Use of Reservoir Energy

The efficient use of the reservoir energy of each pool as a unit is contemplated in the fixing of the production quota for the pool. Assuming the observed reservoir pressure to be the best available index of energy for the pool as a whole, the reservoir pressure of each unit in the pool as compared to that of the pool must be the producing unit index.

There is some disagreement as to the weight or proper application of reservoir pressures to a proration plan. It may be that too much value is placed on individual well pressures in this plan, but the writer does not think so.

Pressure decline is a function of withdrawal, whether the withdrawal be oil, gas, water, or all these. This fundamental fact applies in general to all pools, but is not true so generally when applied to the units within a pool.

Structural position has a great bearing upon observed pressure change. In a water-drive pool[6] a producing unit remote from encroaching water may have a lower pressure than either the pool as a whole or producing units nearer the water source, but due to its advantageous structural position, the lower pressure unit gains ultimately in the efficient usage of the pool energy. Such a unit, as a rule, is found high upon the productive structure.

Units in a gas-driven pool[7] are in a converse position. Those units located high upon the structure have a natural disadvantage in that they are situated in or near the gas cap, which must expand with pool exploitation. This natural expansion of the gas cap will in time increase the operating gas-oil ratio of the units so located and, therefore, increase the quantity of reservoir energy expended for each barrel of oil recovered from the producing unit.

If the producing units are of appreciable size and uniformly spaced, then, by the proper completion of wells, the keeping of reservoir pressure in equilibrium, and the maintenance of the most efficient or lowest operating gas-oil ratios possible, the greater can be the use made of reservoir energy. Natural equity in the form of advantageous structural position must be recognized under a modified law of capture in both current and ultimate use of common energy.

Allocation of Production

Before the passage of the law governing production practice, production quotas were distributed to the producing units in each pool upon a basis of acreage, bottom-hole pressure, and gas-oil ratio. Weight in the distribution formula was divided equally between acreage and pressure and then adjustment made for the operating gas-oil ratio if the ratio was above the average for the pool. This formula is commonly spoken of as the 50 percent acreage *plus* 50 percent pressure formula.

The derivation and application of this *plus* formula were as follows: (1) the optimum rate or quota for the pool was divided into two parts, (2) the acreage of each unit was totaled and the pressure of each unit in the pool also totaled, (3) one part of the quota was divided by the pool acreage sum and the other by the pool pressure sum, (4) each division quotient represented the barrelage value of one acre and one pound, respectively, (5) the acreage of each unit and the pressure of each unit were then multiplied by their respective quotient factors, and (6) the sum of the two products constituted the basic daily allowable for the unit.

Any plus formula used in allocating production contains inherent weaknesses that prevent the maximum realization of equitable distribution. For instance, a fractional unit having only half the acreage of a full unit, both units having the same pressure, would receive three-quarters as much allowable as the full unit.

To approach equity more closely in the production of oil and gas and in the use of reservoir energy, the same basic factors of acreage, pressure, and gas-oil ratio are now used, but in a more direct manner. The formula is known as acreage *times* pressure, or acre-pound proration. *The active use of this formula by state authority is found only in Arkansas.*

The operation of this *times* formula is much simpler than the *plus* formula, as can be seen: (1st) the acreage of the unit is multiplied by the pressure of the unit, (2nd) such products (acre-pounds) are then totaled for the pool as a whole, (3rd) the production quota for the pool is then divided by the total acre-pounds of the pool, (4th) the division quotient then represents the barrelage value of one acre-pound, and (5th) the acre-pounds of each unit multiplied by the quotient factor constitutes the basic daily allowable for the unit.

Exhibit No. 2, depicting the Magnolia field, has the highest production quota of any pool in the state. For the month of November, 1940, the optimum rate was fixed at 19,387 bbl. daily. The sum of the individual unit acre-pounds is 14,438.8 thousand, and upon dividing the allowed oil quota by the acre-pounds, a factor of 1.35117 bbl. is obtained as the value of 1000 acre-pounds.

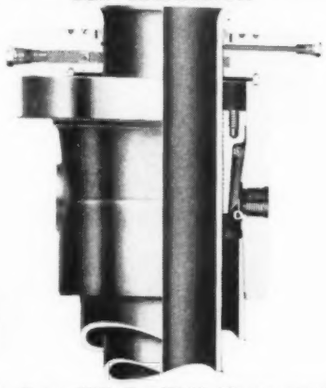
Exhibit No. 6 representing the Jones pool, provides another type of example inasmuch as it is a gas-driven pool, whereas Exhibit No. 2, just discussed, depicts a water-drive pool. For the month of November, 1940, the optimum rate was fixed at 13,607 bbl. daily, having been reduced due to increasing gas-oil ratio. The sum of the individual unit acre-pounds is 5477.5

[6] "Development and Early Exploitation of a Water-Driven Oil Pool Under Proration," by Alec M. Crowell, *The Petroleum Engineer*, November, 1939.

[7] "Data on Gas-Driven Pool Disclose Characteristics Differing from Water-Driven Reservoirs," by Alec M. Crowell, *The Petroleum Engineer*, October, 1939.

Cameron

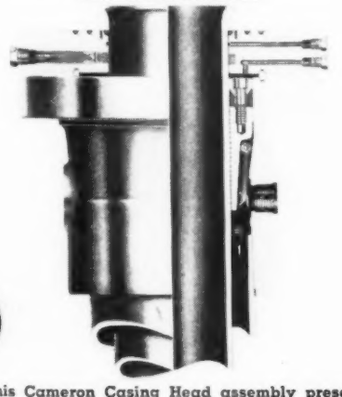
TYPE "M" TEST-WELD FLANGE AND SLIP SUSPENSION



1

The Type "M" Test-Weld Flange provides a welded seal of the space between casing strings and permits testing the weld before installing casing spool or tubing head. A secondary plastic packing seal, which may be safely repacked under pressure, permits application of hydraulic test pressure to the weld. Long slips for extremely heavy casing loads, or regular slips for casing loads up to 250,000 lbs. are interchangeable.

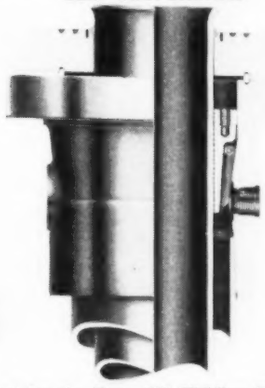
TYPE "WM" TESTING FLANGE FOR NEOPRENE-ASBESTOS SEAL AND SLIP SUSPENSION



4

This Cameron Casing Head assembly presents a combination of the Type "W" neoprene-asbestos seal and the Type "M" Test-Weld Flange with an added testing port. Obviously, the Type "WM" Testing Flange permits the introduction of hydraulic test pressure to the neoprene-asbestos seal. If desired, the casing may also be welded to the Type "WM" Flange and the weld tested in the usual manner.

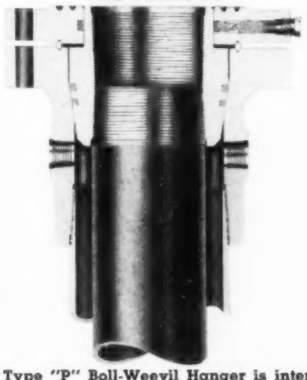
TYPE "J" WELDING FLANGE AND SLIP SUSPENSION



2

Except for the Type "J" Welding Flange, which provides no means for testing the weld, this Cameron Casing Head assembly is identical to the assembly shown at left. Note that both the Types "M" and "J" Welding Flanges are provided with a stress-relieving groove between the chamfer and the inside ring groove.

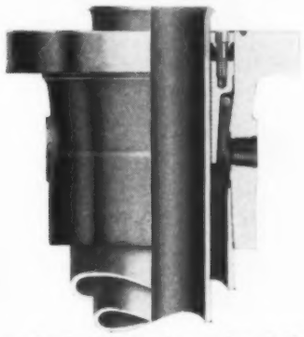
TYPE "P" BOLL-WEEVIL SUSPENSION WITH AUXILIARY REPACKABLE SEAL ABOVE THE HANGER



5

The Type "P" Boll-Weevil Hanger is interchangeable with slip type hangers in any Cameron Casing Head. A primary seal of the space between casing strings is effected by resilient packing rings on the hanger. An auxiliary repackable plastic packing seal around the shank of the hanger is provided in the lower flange of the next unit, or, in an auxiliary flange as shown.

TYPE "W" NEOPRENE-ASBESTOS SEAL AND SLIP SUSPENSION



3

Where Grade N-80 casing makes field welding impractical, or for operators who prefer a resilient seal to a welded seal, this Cameron Casing Head assembly with slip suspension and a neoprene-asbestos seal between casing strings is highly recommended. The packing is expanded by tightening socket head cap screws which screw directly into the top of the slips . . . a feature that facilitates expanding the packing and eliminates exposed threads which are often damaged by drilling tools.

Have You Received Your Copy of This Interesting Booklet?

The "Cameron Closed Pressure Method of Drilling and Completion" explains, step-by-step, the modern method of drilling and completing high pressure wells. A copy of this booklet will be gladly sent to interested operators on request.

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thousand, and upon dividing the allowed oil quota by the acre-pounds, a factor of 2.671607 bbl. is determined as the value of 1000 acre-pounds.

Utilization and operating contracts are now being circulated among the owners of the Jones pool. It is expected that repressuring operations will be under way in this pool within the next six months.

Gas-Oil Ratios

The accuracy of gas volume figures obtained in any oil field is open to question, especially where the volume of gas produced with the oil is relatively small or where there is material difference in operating ratios between producing units.

Even with the best of measuring equipment, very small volumes of gas are difficult to measure in the field, and where volumes vary from unit to unit and operating ratios are a factor in oil allowable determination, the tendency is to disregard measured increases.

As in the case of reservoir pressure measurement, the engineers of the Commission ascertain, by actual test, the operating gas-oil ratio of each prorated unit. This practice promotes harmony and avoids confusion.

Rather than require the expense of the installation of complete gas-measuring equipment at each producing unit, only the installation of runs and orifice flanges is required. Some operators prefer to install meters, even though it is not required, in order that permanent records may be kept and also to insure accuracy in the Commission's test.

The engineers employ portable type meters, calibrated for accuracy, and test each unit each month for gas-oil ratio. It was found after experimentation that ratio tests of 6 hours duration were representative and checked very closely with volumes actually metered over longer periods.

In general, gas-oil ratios from unit to unit vary rather closely with the difference in those units in the method of completion and position on the productive structure. Specifically, perhaps the greatest factors governing operating ratios are the rate of production, structural position, and the liberation of solution gas.

Drilling and completion practices in the prorated pools are so controlled that the base or lower casing in all wells is set well below the point of gas-oil contact or the wells are cased completely through the producing formation and gun-perforated into the oil column.

Minimum ratios are necessary in optimum rate proration both from the standpoint of the units in a pool and each pool as a whole. Inefficient ratios will result in positive waste of energy and cause diminishing ultimate recovery in any oil pool.

Gas-oil ratios are subject to control, as can be illustrated. Exhibit No. 3 will give a concrete example of faulty completion later remedied. In this case one well was completed at the exact point of gas-oil contact and the ratio of gas to oil originally was 58,000 cu. ft. per bbl. Upon recompletion the volume was lowered to less than 1000 cu. ft. per bbl. of oil and has remained at that figure.

Exhibit No. 5 illustrates a pool of inherently high gas-oil ratio characteristics. The producing section, so far as oil is concerned, is thin and of highly permeable oölitic lime. The gas cap is in fact much larger than the oil section.

In July, 1939, the pool was placed under volumetric control with the result shown on the chart. The average pool ratio has decreased and the reservoir pressure increased. The pool quota has been reduced again, after Exhibit No. 5 was drawn, with most satisfactory results.

Although the formula used in Exhibit No. 5 is a volumetric one, it is modified considerably. As of September, 1940, the average reservoir pressure of the pool was 3319 lb. per sq. in. and gas-oil ratios varied from 1890 cu. ft. to 13,137 cu. ft. per bbl. among producing units. The Commission ruled that not more than 521.45 bbl. of reservoir voidage daily, in the interest of efficiency, could take place from any unit.

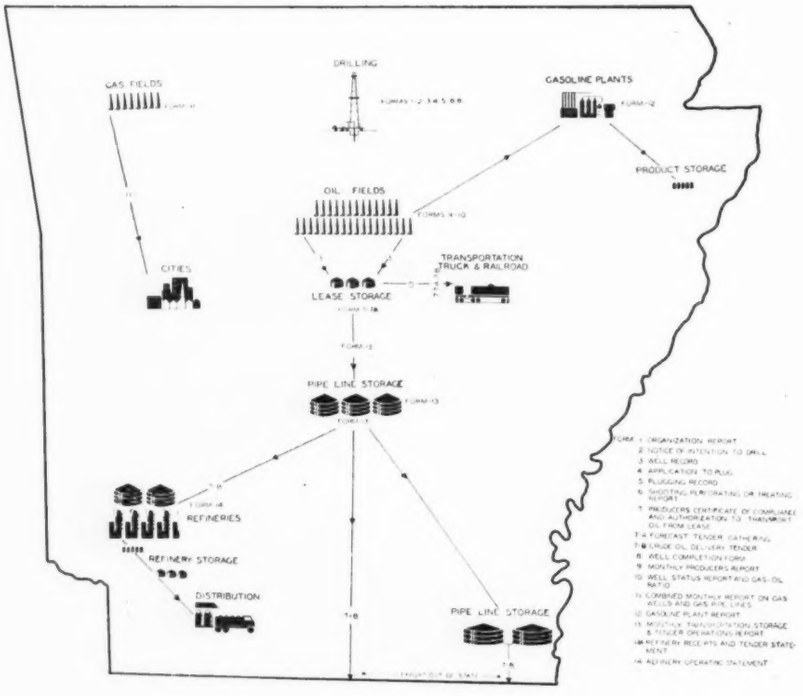
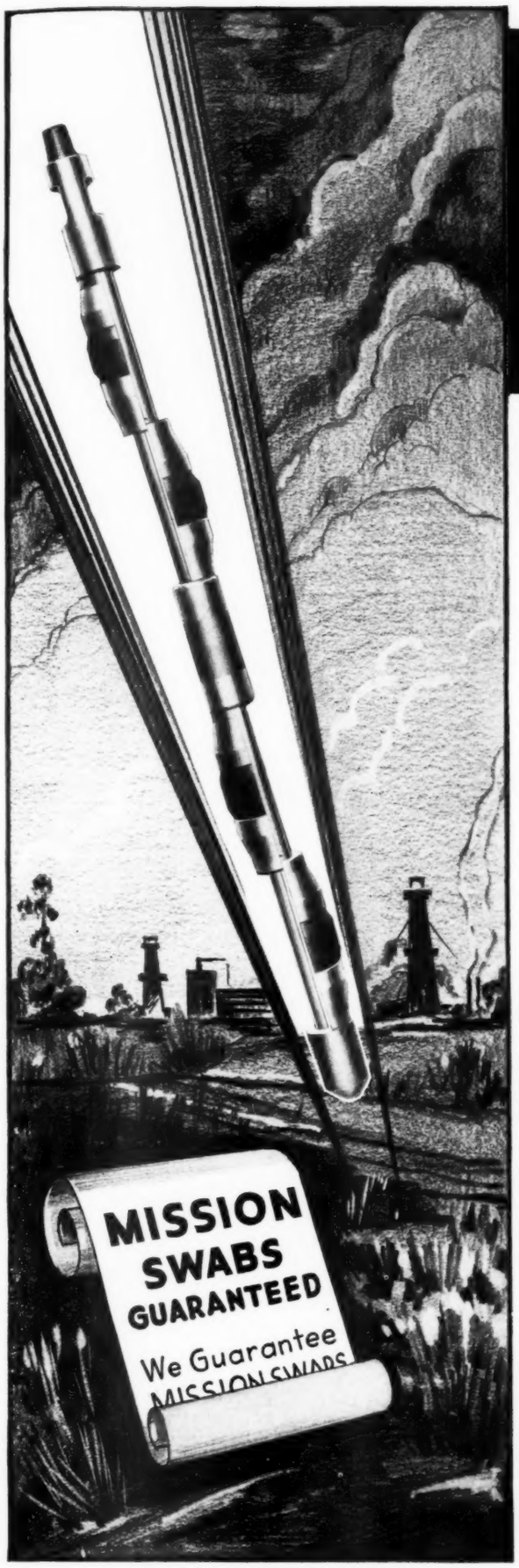


EXHIBIT 9

Schematic Illustration of Reporting System

Under this model reporting and tender system, covering the industry in all its phases, only nine non-recurring and nine recurring forms are required. The oil producer files only one report, and that covering oil produced, the gas-oil ratio report is provided by the Commission engineers. Drilling and Conservation are covered by six non-recurring forms only. Gas Production by two recurring. Transportation by one non-recurring and four recurring, and Processing by one non-recurring and two recurring reports. Relatively, few reports are required and the information they contain is gathered in the normal course of business.



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Gas-oil ratio adjustment of allowables is made only in one of two ways. The volumetric method just illustrated is best perhaps where there is a wide ratio variance between producing units but where fairly uniform pressure conditions prevail.

The second method, and perhaps the most conventional, is widely used by all prorating states. The mechanics of the normal procedure are as follows: (1st) a specified operating unit ratio limit is fixed for the pool, (2nd) the volume of gas displaced by the average full unit in the production of its allowable is accepted as a criterion, (3rd) for each unit having a ratio in excess of the specified ratio, the total volume of gas it can produce cannot exceed the criterion volume, (4th) consequently the operating ratio of the inefficient well is divided into the criterion volume and the resultant quotient is the well's daily oil allowable.

Under this plan of gas-oil ratio adjustment, there is an appreciable amount of oil represented in the series of necessary reductions. This oil is redistributed to the wells having more efficient ratios in order that the total pool quota may remain at its optimum rate.

Basic Data on Pool Exhibits

Although only five Arkansas pools are charted for illustrative purposes in this article, the development and exploitation of the other pools under proration are carried out in the same manner and are all controlled on an acre-pound basis. Two of the pools are of the so-called distillate or condensate type. Fortunately, the statute will allow these pools to be classed as gas fields and the wider spacing demanded by their type of production can be satisfied. The pools are producing fluid with A. P. I. gravities as high as 65° from depths to 9200 ft., but with gas-oil ratios below those normally expected. Reservoir pressures are normal but the gas produced may contain as much as 4000 grains of hydrogen sulphide per 100 cu. ft. Active water drive and optimum production rates thus far have solved the critical pressure or retrograde condensation problem.

Every effort has been made to gather all the basic information available concerning the prorated pools, and the operators have coöperated to the fullest extent in this undertaking. An unusually large number of wells has been cored and the cores analyzed, bottomhole samples have been taken in each pool, and, all in all, a surprising volume of information has been accumulated.

Data	Exhibit Number				
	2	3	4	5	6
Name of field	Magnolia	Buckner	Reynolds	Village	Jones
Location, county	Columbia	Lafayette	Union	Columbia	Union
Formation	Lime	Lime	Lime	Lime	Sand
Discovery date	4/5/38	11/31/37	10/22/37	5/26/38	9/17/37
Well spacing, acres	40	40	40	40	20
Gas-oil contact, ft	—7138	Solution	—7394	—7101	—7280
Water-oil contact, ft	—7321	—7010	—7420	—7123	—7380
Effective section, ft	95	30	20	15	37.5
Porosity, percent	18.5	20	20	20	17.6
Permeability, millidarcies	1500	20	1500	700	350
Connate water, percent	20	25	20	20	15
Shrinkage factor, percent	30	12	30	30	34.8
Recovery factor, percent	50	40	50	50	35
Producing acreage	4390	840	629	440	2944
Type drive	Water	Water	Water	Water	Gas
Gas-oil ratio	960	275	1000	4590	5000
Gravity of oil	38	32.5	38	41	34
Original pressure, lb. per sq. in.	3465	3195	3550	3350	3520
Current pressure, lb. per sq. in.	3280	2743	3379	3304	1670
Oil produced, in thousand bbl.	10,609	1759	2273	762	15,730
Gas produced, in million cu. ft.	8000	400	4500	400	19,000
Estimated original oil reserves, in million bbl.	140*	7.2	5.5	4	36.5

*Reserves are carried by many at 180 million bbl. Difference due to recovery factor and effective section used.

Aside from the information given in the tabulation, productivity tests have been conducted on representative wells in each pool, slippage tests in tubing studies, and a great many intermittent or stop-cocking tests have been made. All these data are at hand and more are being added from time to time.

The reason for this is that the Commission believes that future technological advance will provide for even greater ultimate recoveries than can be expected under what we believe are optimum conditions now. That is the history of the industry.

Wide Open Flow Vs. Optimum Conditions

The Commission was called upon in July, 1940, to submit a report to the National Defense Council giving, among other things, the potential capacity of the various oil pools of the state to produce over a period of time in an emergency. Potential tests on oil wells in prorated pools have never been conducted within the common meaning of "potential." Productivity tests have been conducted periodically on wells in all pools but to determine only the producing ability of the strata within the drainage radius of a specific well. These tests are commonly referred to as "productivity indices" as expressed in "the number of barrels of oil recoverable each day of 24 hours for each pound pressure decline."

A committee of thirteen[8] has assisted in obtaining these productivity indices and a group study of their worth in proration practice will be made at some later time.

[8]An engineering committee composed of P. D. Baker, Standard Oil Company of Louisiana, John Murrell, Shell Oil Company, Inc., Dr. Herman Kaveler and I. H. Hughes, Phillips Petroleum Company, F. W. Turner, Atlantic Refining Company, T. R. Wade, Tide Water Associated Oil Company, H. O. Kirkpatrick, Arkansas Fuel Oil Company, Frank Richardson, Lion Oil Refining Company, and C. H. Thigpen, J. A. Simms, Howard Waddle, L. L. Jordan, Alec Crowell, of the Arkansas Oil and Gas Commission.

In the absence of better data, these indices were employed, together with additional tests, conducted for the purpose of completing the recorded indices, so as to have representative information from which an average index for each pool could be calculated. The final pool average index was used to indicate the calculable ability of each well in the pool to flow unrestricted through the oil string or base casing the first day of open flow.

It has been observed that most of the early unrestricted pools in South Arkansas and adjacent areas, after being completely developed, had a straight "log-log" decline in production; i.e., the total production plotted against time on log-log coördinates could be made a straight line. This has also been found true of more recently developed fields, after they had passed the stage of restricted production and were producing at the maximum rate of which they were capable.

To illustrate the maximum flow characteristics of present flush or prorated pools, it was decided that without better information a "log-log" decline characteristic would be most likely. By means of data available on the various pools, their maximum first day potential was estimated. In each case an estimate had been made on the volumetric basis of the ultimate recovery for that field under efficiently restricted flow.

It was then assumed that should these same fields be opened to maximum possible withdrawals, their ultimate recovery would vary between 40 and 50 percent of the amount estimated to be recoverable under efficiently restricted flow. The daily amount of oil that would be produced at the field's economic limit was also assumed.

Thus, having assumed the daily production rate for the first day and for the last day, and having assumed the total amount of oil to be recovered

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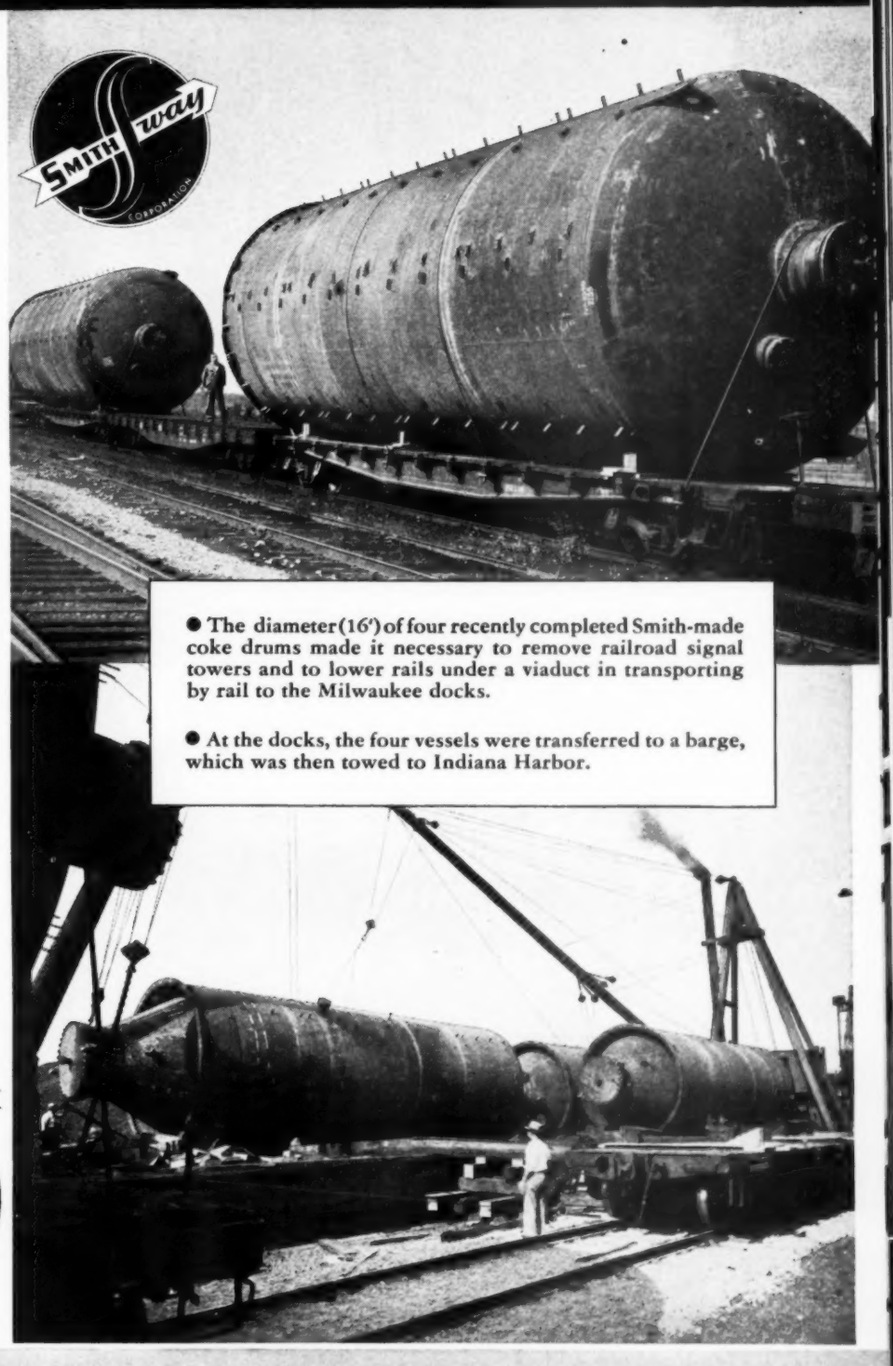

● The diameter (16') of four recently completed Smith-made coke drums made it necessary to remove railroad signal towers and to lower rails under a viaduct in transporting by rail to the Milwaukee docks.

● At the docks, the four vessels were transferred to a barge, which was then towed to Indiana Harbor.

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● A. O. Smith has a *daily* capacity of 12,000 steel frames for autos, trucks, and busses. That number of vehicles is a potential annual consumer of approximately 5,000,000 gals. of gasoline and 100,000 gals. of oil.

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during the interim, it becomes mathematically possible to derive formulas based on straight "log-log" decline that will determine the duration of time between the first day and the last day, and the relationship of production rate to time during the interim.

Exhibit No. 7 graphically illustrates for comparative purposes the daily decline and cumulative recovery of oil under wide open flow and optimum conditions for one of these fields. Briefly, it is estimated that the ultimate recovery would suffer by 60 percent under potential flow and that approximately 40 percent of the expected recovery would be obtained the first year.

Applying the method to each of the pools that have been exhibited, the following approximations are obtained:

Exhibit no.	Volmetric oil in place, in thousand bbl.	Recoverable oil	
		Optimum conditions, in thousand bbl.	Open flow, in thousand bbl.
2	280,000	140,000	56,000
3	14,400	7,200	2,900
4	11,000	5,500	2,200
5	8,000	4,000	1,600
6	104,500	36,500	20,800
		193,200	83,500

Indicated loss by open flow or gain by optimum rate, 109,700,000 bbl.

P. D. Baker, petroleum research engineer for the Standard Oil Company of Louisiana and a member of the committee,[8] derived the formula applied in the mechanics of the estimations. Exhibit No. 8 illustrates the formula and its application to the Magnolia field.

It must be clearly understood that the calculations were required to supply an urgent need and the results are not given as proved. Future work is being done along these preliminary lines and it is hoped that concrete evidence with new figures can be given in time. In the meantime, the foregoing discussion is granted as hypothetical and, although it is believed to be correct, it is open to considerable dispute.

General

An effort has been made to cover, as briefly as possible, practically all the points that would be of interest to engineers. There are many other points that would be interesting, perhaps, to other branches of the industry, especially to those who are charged with the duty of preparing myriad governmental forms and reports.

The number of reports required from operating companies in Arkansas is kept at the very minimum. To Guy L. Tate, vice-president of the Magnolia Petroleum Company, should go the credit for the reporting system employed. He spent weeks with other representatives of the industry and agents of the Commission in designing reports that would be complete, nonburdensome, and uniform. After hearing, the system was adopted and there has never been a change made.

A streamlined system of certificates of clearance or "tenders" is also used as a coöperative means of obtaining the fullest support of the Connally Act. Again, as in so many constructive measures, the industry recommended this move and the program was initiated with the assistance of the Federal Tender Board.

If proration is no better than the law under which it operates and a law is doubtful until proved by litigation, then the statute in this case should be satisfactory. Two instances of litigation, one before the Chancery Court of Union County[9] that was appealed to the State Supreme Court and decided in favor of the Commission in both courts, and the other before the District Court of the United States,[10] also decided in favor of the Commission, have removed any doubt as to the effectiveness of the law or the authority of the Commission.

The cost of the administration of this system of proration-conservation has been borne thus far by the owner and producer of oil and gas. An assessment of 2.5 mills for each bbl. of oil produced and saved supports all cost and the levy applies only to the production from pools operating under restriction. No funds may come from general taxation, nor can any part of the proration assessment be diverted to channels other than the administration of the Conservation Act.

Summary

Pogue[11] has perhaps written more on proration than any other author. He suggested certain steps or points quite recently in an address before the American Institute of Mining and Metallurgical Engineers on the subject of a design for more effective proration. Four of these suggestions are listed herewith:

1. The development of the optimum rate concept as a yardstick for restricting the individual oil pool.
2. The standardization of the application of bottom-hole pressure readings for the effectuation of ratable takings.
3. The harmonizing of drilling incentives with the requirements of delayed production.
4. The employment of market demand quotas to reconcile the interim differences between optimum rates and market requirements.

Foley[12] has reviewed the proration practices of all the prorating states, and has also made recommendations. As a suggested solution of the spacing problem he says: "In many fields, there are tracts that are smaller than a normal drilling location. It might be possible to unitize small tracts into drilling sites without necessarily unitizing the field."

These suggestions are incorporated in the scheme of proration adopted in Arkansas. It is also believed that the soundness of the theory advanced is well substantiated by demonstration.

Concluding Remarks

The oil industry has guided the course in this particular proration-conservation movement to the benefit and satisfaction of the state and the producer. Planned economy and proved technology blend into apparent stability. The adoption of unit operation by implementation is bringing about efficient development and economic depletion of reserves and the prudent conservation and utilization of natural reservoir energy are preventing waste and should provide ultimate in recovery. The profitability probabilities are most satisfying.

APPENDIX

From the text "Arkansas Laws Governing the Natural Resources of the State" by Robert A. Leflar, Professor of Law, University of Arkansas, this summary of the Oil and Gas Conservation Law is taken:

"By Act 105 of 1939, there is created an Oil and Gas Commission consisting of seven members appointed by the Governor, with power to hire employees and to function as a supervising authority over the production of oil and gas in Arkansas. A principal purpose of the law is to set-up machinery for the elimination of wasteful and unprofitable over-production of oil and gas in the State. The Commission is authorized to achieve this end by setting up a system of 'proration' restricting wells to a specified daily production. In order to achieve the ends sought by 'proration,' it is necessary that a considerable measure of coöperation between the bodies administering conservation systems in the various oil and gas producing states must occur, and it is a fact that the laws of most of the states do provide for such cooperative action.

[9] In Union Chancery Court, Second Division, August 21, 1939, Case No. 6389. Lion Oil Refining Company vs. O. C. Bailey et al. The right of the Commission to close-in oil pools for the purpose of investigating reservoir conditions, etc., was challenged. This court held that it was within the authority of the Commission. Upon appeal, the Supreme Court of Arkansas on April 22, 1940, affirmed the decree of the trial court.

[10] District Court of the United States, Western District of Arkansas, El Dorado Division, Civil Action, File No. 54. Lion Oil Refining Company vs. O. C. Bailey et al. Attempt to enjoin the use of acre-pound proration and substitute acre-foot-pound proration. Injunction denied July 8, 1940.

[11] Joseph E. Pogue, "A Design for More Effective Proration." *Transactions A.I.M.E.* (1939) 132, 206-214. (List of earlier papers on page 214).

[12] Lyndon L. Foley, "Proration of Oil Production," *The Mines Magazine*, June, 1939, and "Proration of Allowable Oil Production," A.P.I. *Drilling and Production Practice* (1937) 427-436. Also "Spacing of Oil Wells," *Transactions A.I.M.E.* (1938) 127, 15.

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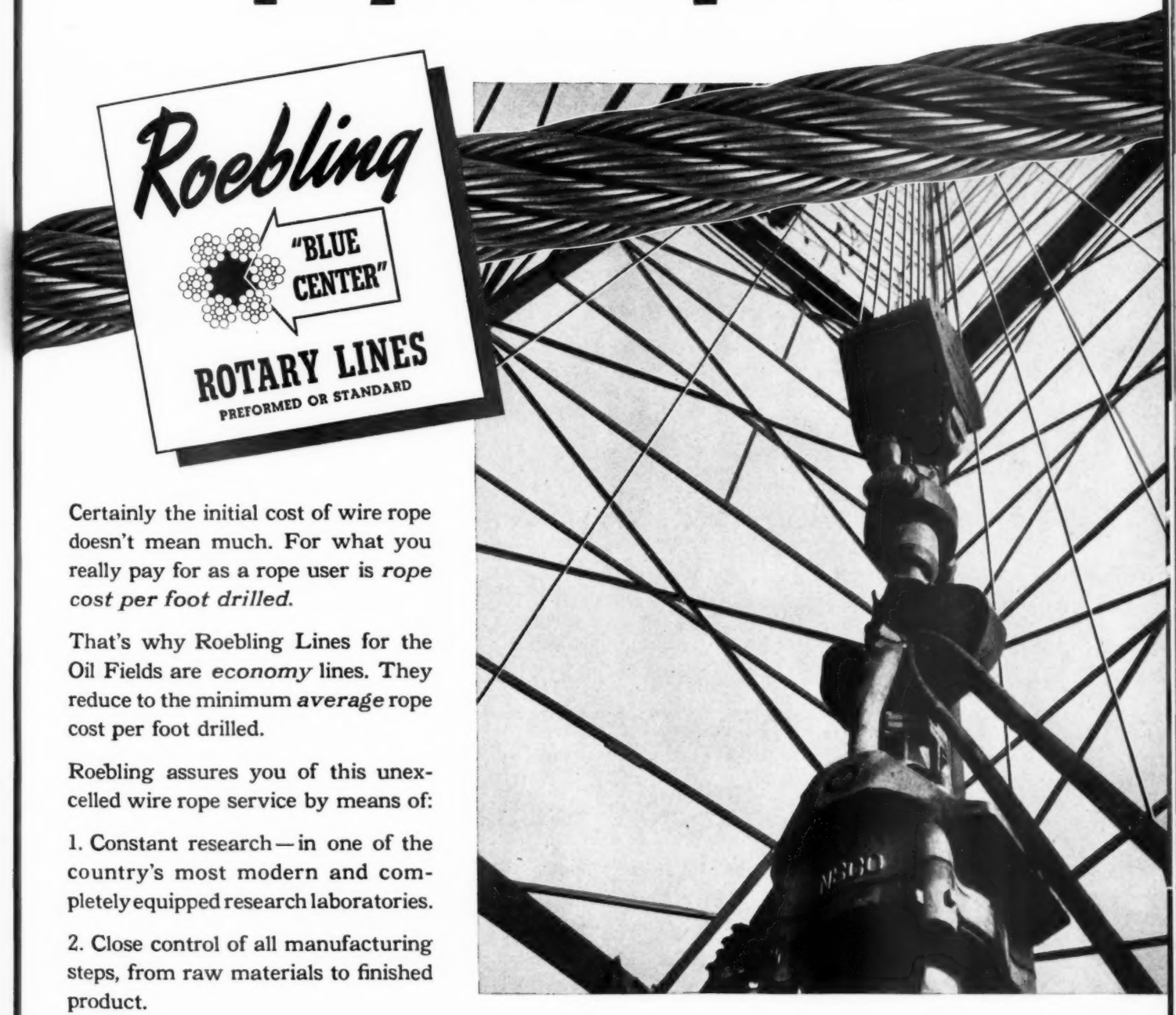

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"Apart from 'proration,' however, the Arkansas Commission is vested with numerous powers designed to aid in the conservation of the oil and gas resources of the State. For example, the act prohibits and the Commission is empowered to punish 'waste' in the operation of oil and gas wells, and the law proceeds to define 'waste' as follows:

"1. 'Waste' in addition to its ordinary meaning shall mean 'physical waste' as that term is generally understood in the oil and gas industry. It shall include:

"(1) The inefficient, excessive, or improper use or dissipation of reservoir energy; and the locating, spacing, drilling, equipping, operating, or producing of any oil or gas well or wells in a manner which results, or tends to result, in reducing the quantity of oil or gas ultimately to be recovered from any pool in this State.

"(2) The inefficient storing of oil; and the locating, spacing, drilling, equipping, operating, or producing of any oil or gas well or wells in a manner causing, or tending to cause, unnecessary or excessive surface loss or destruction of oil or gas.

"(3) Abuse of the correlative rights and opportunities of each owner of oil or gas in a common reservoir due to nonuniform, disproportionate, and unratable withdrawals causing undue drainage between tracts of land.

"(4) Producing oil or gas in such manner as to cause unnecessary water channeling or coning.

"(5) The operation of any oil well or wells with an inefficient gas-oil ratio.

"(6) The drowning with water of any stratum or part thereof capable of producing oil or gas.

"(7) Underground waste however caused and whether or not defined.

"(8) The creation of unnecessary fire hazards.

"(9) The escape into the open air, from a well producing both oil and gas, of gas in excess of the amount which is necessary in the efficient drilling or operation of the well.

"(10) The use of gas for the manufacture of carbon black.

"(11) Permitting gas produced from a gas well to escape into the air. (Sec. 9, Act 105 of 1939, approved February 20, 1939).

"In addition to these specific prohibitions, the Commission is authorized to promulgate regulations designed to aid in the prevention of waste. The statute lists the following purposes for which such regulations may be issued, with the force of law:

"A. To require the drilling, casing, and plugging of wells to be done in such a manner as to prevent the escape of oil or gas out of one stratum to another; to prevent the intrusion of water into an oil or gas stratum from a separate stratum; to prevent the pollution of fresh water supplies by oil, gas, or salt water; and to require reasonable bond conditioned for the performance of the duty to plug each dry or abandoned well.

"B. To require the making of reports showing the location of oil and gas wells, and the filing of logs and drilling records.

"C. To prevent the drowning by water of any stratum or part thereof capable of producing oil or gas in paying quantities, and to prevent the premature and irregular encroachment of water which reduces, or tends to reduce, the total ultimate recovery of oil or gas from any pool.

"D. To require the operation of wells with efficient gas-oil ratios, and to fix such ratios.

"E. To prevent 'blow-outs,' 'caving,' and 'seepage' in the sense that conditions indicated by such terms are generally understood in the oil and gas business.

"F. To prevent fires.

"G. To identify the ownership of all oil or gas wells, producing leases, refineries, tanks, plants, structures, and all storage and transportation equipment and facilities.

"H. To regulate the 'shooting,' perforating, and chemical treatment of wells.

"I. To regulate secondary recovery methods, including the introduction of gas, air, water, or other substance into producing formations.

"J. To limit and prorate the production of oil or gas or both, from any pool or field for the prevention of waste as herein defined.

"K. To require, either generally or in or from particular areas, certificates of clearance or tenders in connection with the transportation of oil or gas.

"L. To regulate the spacing of wells and to establish drilling units.

"M. To prevent, so far as is practical, reasonably avoidable drainage from each developed unit which is not equalized by counter drainage. (Sec. 11, Act 105 of 1939, approved Feb. 20, 1939)."

P 205.111.31

Analysis of Crude Oil from Phillips County, Kansas, Well

THE crude oil produced from a discovery well in Phillips County, Kansas, has an intermediate base, according to an analysis recently made by the U. S. Bureau of Mines, at its Petroleum Experiment Station, Bartlesville, Oklahoma. The gravity of the sample is 31.7 deg. A.P.I. and the sulphur content (0.57 percent) is relatively high. The analysis made by the Bureau of Mines Hempel method shows a total gasoline and naphtha content of 24 percent, with approximately 9 percent of kerosine distillate, 15 percent of gas oil, 18 percent of lubricating distillate, and 34 percent of residuum.

The discovery well, Ray No. 1 of the Cities Service Oil Company, is in Sec. 32, T. 5 S., R. 20 W., approximately 30 miles south of the Kansas-Nebraska State line. This well is now the northwest outpost of production on the Barton Arch, a geological uplift on which there are a number of oil-producing areas in west-central and northwestern Kansas. The producing formation has been tentatively identified as Reagan sandstone and the well was completed by setting casing on bottom and gun-perforating the casing at a depth of 3543 to 3563 ft.

The "potential" of the well obtained by the "echometer" indicated an initial production of 2135 bbl. per day.

The analysis of the oil follows.

Logan Pool	Kansas
Producing formation,	Phillips County
Reagan sandstone (?)	Sec. 32, T. 5 S., R 20W.,
Depth, 3543-3563 ft.	6th Prin. Merid.

GENERAL CHARACTERISTICS

Specific gravity, 0.867	A.P.I. gravity, 31.7°
Sulphur, percent, 0.57	Color, brownish-black

Saybolt Universal viscosity at 77°F., 100 sec., at 100°F., 72 sec.

DISTILLATION, BUREAU OF MINES HEMPEL METHOD

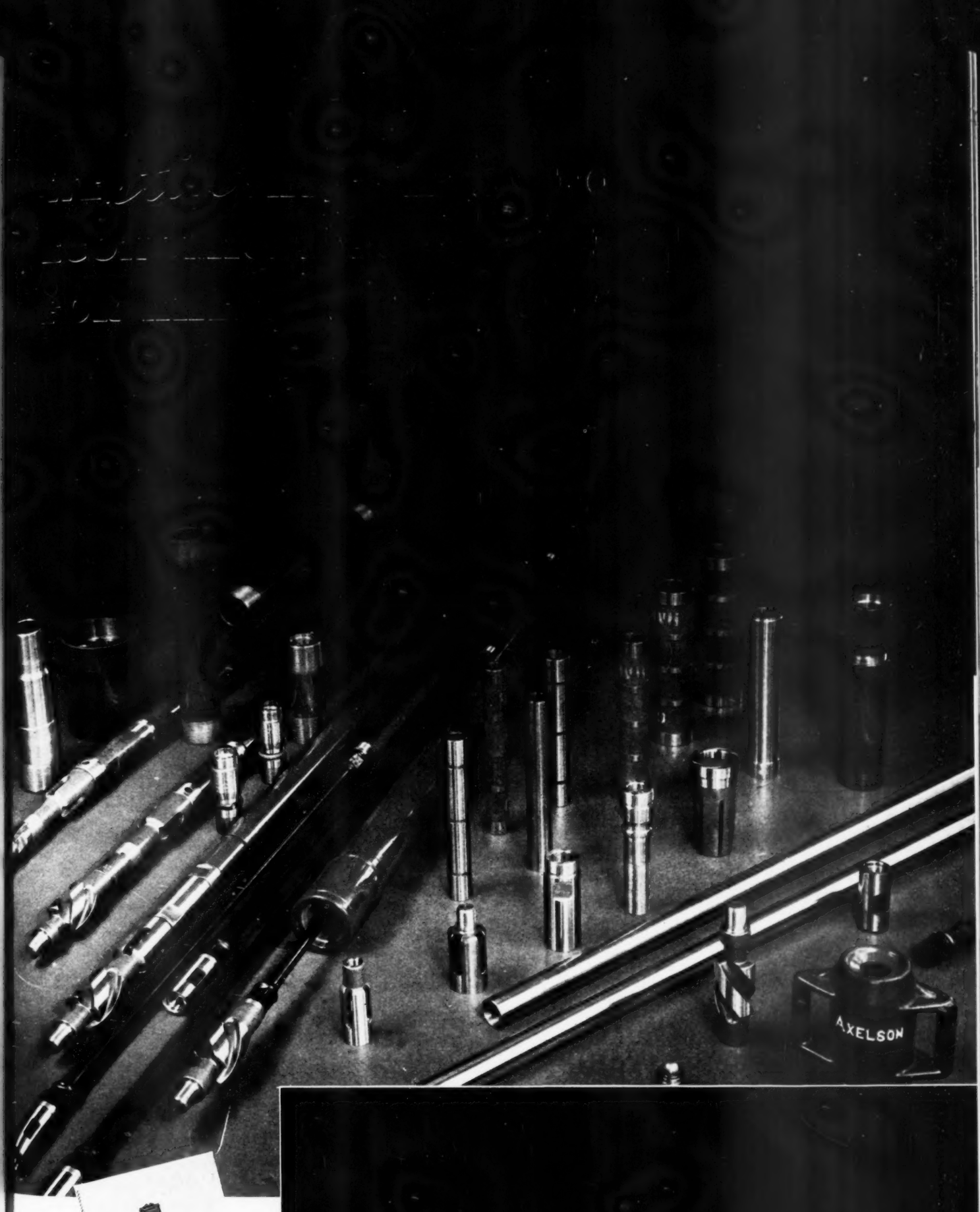
Distillation at atmospheric pressure, 746 mm. First drop 35°C. (95°F.)

Fraction No.	*Cut °C.*	*at °F.*	*Percent*	*Sum percent*	*Sp. Gr. 60/60°F.*	*°A.P.I. 60°F.*	*C.I.*	*S. U. visc. 100°F.*	*Cloud test °F.*
1	50	122	1.2	1.2	0.648	86.9			
2	75	167	3.9	5.1	.674	78.4	9.4		
3	100	212	2.2	7.3	.714	66.7	18		
4	125	257	4.7	12.0	.732	61.8	18		
5	150	302	3.9	15.9	.749	57.4	18		
6	175	347	4.1	20.0	.766	53.2	20		
7	200	392	4.0	24.0	.784	49.0	22		
8	225	437	4.1	28.1	.800	45.4	24		
9	250	482	4.7	32.8	.814	42.3	25		
10	275	527	6.1	38.9	.827	39.6	27		
Distillation continued at 40 mm									
11	200	392	4.5	43.4	0.847	35.6	32	41	10
12	225	437	5.7	49.1	.856	33.8	33	47	30
13	250	482	5.0	54.1	.870	31.1	36	60	50
14	275	527	5.2	59.3	.882	28.9	39	89	65
15	300	572	5.9	65.2	.893	27.0	41	155	80
Residuum			33.8	99.0	0.974	13.8			

Carbon residue of residuum 15.6 percent; carbon residue of crude 5.3 percent.

APPROXIMATE SUMMARY

	Percent	*Sp. Gr.*	*°A.P.I.*	*Viscosity*
Light gasoline	7.3	0.682	76.0	
Total gasoline and naphtha	24.0	0.734	61.3	
Kerosine distillate	8.8	0.807	43.8	
Gas oil	14.7	0.841	36.8	
Nonviscous lubricating distillate	10.2	0.859-0.883	33.2-28.8	50-100
Medium lubricating distillate	7.5	0.883-0.899	28.8-25.9	100-200
Viscous lubricating distillate				Above 200
Residuum	33.8	0.974	13.8	
Distillation loss	1.0			



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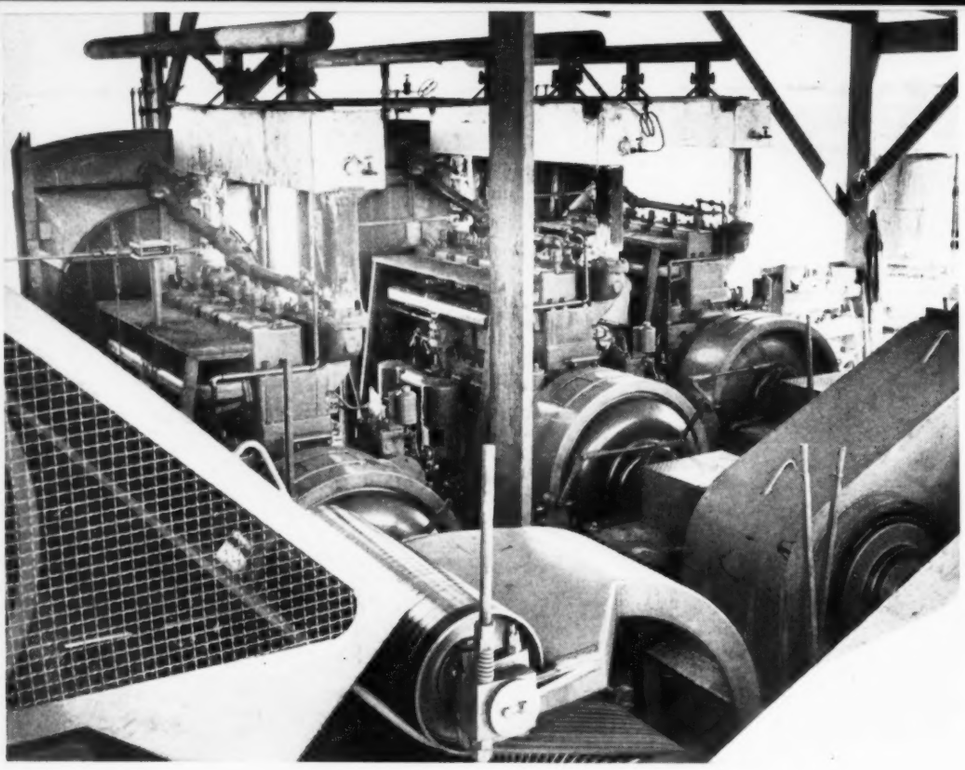

P 422.3

The three hydraulic couplings can be seen mounted on the flywheels of the gas engines that power the rig

PETROLEUM ENGINEER EXCLUSIVE FEATURE

By
WALLACE A. SAWDON
Pacific Coast and Foreign Editor

Hydraulic Couplings Promote Flexibility In Power Control of Drilling Equipment

New mechanical rig employs three 335-hp., 6-cylinder gas engines, each equipped with a coupling of the scoop-control type

THE theoretical advantages of hydraulic couplings used with internal-combustion or electric motors have been recognized for some time but actual performance of such couplings when employed in connection with rig equipment has now provided more definite assurance as to the adaptability of the hydraulic drive in well-drilling operations. Hydraulic couplings have been utilized for a number of years in foreign fields, particularly when Diesel engines have been employed as prime movers. A few weeks ago, a mechanical rig using hydraulic couplings was completed in the United States and now offers an opportunity for observation. Moreover, the well drilled with this rig reached a depth of nearly 10,000 ft. and the equipment was of the heavy type now frequently used for deep-hole drilling.

This well is KCL-B, 72-4 at Coles Levee, California, and was drilled by Bell and Loffland, Inc. for the Richfield Oil Company. The prime movers consist of three Waukesha 6-cylinder gas engines rated 335 hp. at 900 r.p.m. A hydraulic coupling is attached to the flywheel of each engine as indicated in Fig. 1 and power is transmitted through V-belts to the mud pumps and drawworks as shown in Fig. 2. The two Ideal C-350 power pumps, having an 18-in. stroke, were equipped with 7¾-in. liners to a depth of 8300 ft. and 6¾-in. liners were used from that depth to the total depth of 9750 ft. The drawworks was an Ideal 23-10½ F.E.

The well was spudded September 19, 1940, and was put on production December 8, 81 days later. A string of $5\frac{9}{16}$-in. drill pipe was used to the 8300-ft. depth and 4½-in. for drilling from that depth to bottom. A 13⅜-in. surface string was cemented at 1412 ft. and a 7-in. water string at 9350 ft. Liner consisting of 438 ft. of 5¾-in. pipe perforated from 9742 ft. to 9633 ft. and from 9592 ft. to 9366 ft. was landed at 9742 ft. The well was completed with 2½-in. tubing set at 9716 ft. and had an initial daily production of 775 bbl. and 2,500,000 cu. ft. of gas through two 1½-in. beans. When on production the flow is limited to approximately 415 bbl. per day through a 14/64-in. bean with tubing and casing pressures of 1500 and 1900 lb. per sq. in., respectively.

The hydraulic couplings used on this rig were of the scoop-control type supplied by the American Blower Corporation. One coupling was attached

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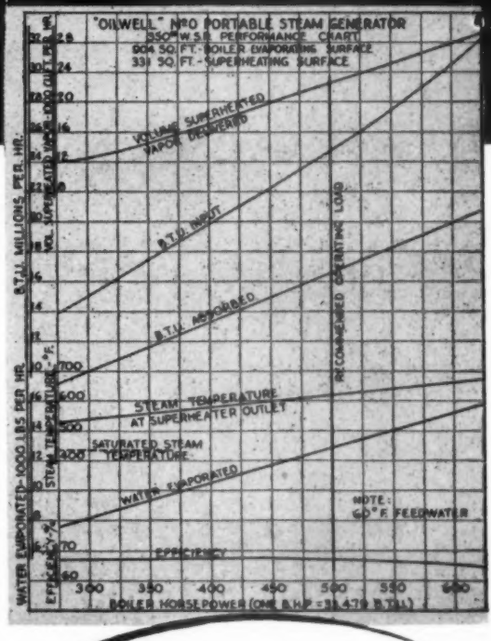
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SATURATED STEAM TEMPERATURE
WATER EVAPORATED
EFFICIENCY
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Welded, rivetless firebox and one-piece, welded barrel are two of the advanced features of the new "Oilwell" No. 0 Portable Superheated Steam Generator. The welded construction improves water circulation, facilitates washing and cleaning, and reduces upkeep by eliminating rivets and overlapping seams.

High tensile strength carbon-silicon steel plates (70,000 lbs. per sq. in. minimum — A.S.M.E. Boiler Specifications S-26) provide light weight in relation to size, strength and capacity.

In addition to its money-saving modern construction features, the No. 0 Steam Generator represents a new and much larger size—106-inch firebox and 68-inch barrel — with correspondingly great increase in boiler-horsepower output. Consistent with the smaller sizes of "Oilwell" Steam Generators, the high and favorable ratio of firebox heating surface to tube heating surface is maintained.

"Oilwell" Portable Superheated Steam Generators are now available in three sizes; all are designed for 350 lbs. per sq. in. working pressure:

SPECIFICATIONS	NO. 0	NO. 1	NO. 2
Weight, Complete: Including Stack . . . . Less Stack	43,035 lbs. 40,935 lbs.	34,853 lbs. 33,263 lbs.	24,300 lbs. 23,150 lbs.
Recommended Operating Load (continuous)	13,000 lbs. of 60° F. water per hr. superheated to 625° F.=500 boiler horsepower	7,900 lbs. of 60° F. water per hr. superheated to 600° F.=300 boiler horsepower	4,800 lbs. of 60° F. water per hr. superheated to 580° F.=180 boiler horsepower
Demonstrated Peak Load (Intermittent).	16,000 lbs. of 60° F. water per hr. superheated to 670° F.=625 boiler horsepower	9,500 lbs. of 60° F. water per hr. superheated to 650° F.=375 boiler horsepower	6,000 lbs. of 60° F. water per hr. superheated to 630° F.=225 boiler horsepower

1 BOILER HORSEPOWER=33,479 B.T.U.

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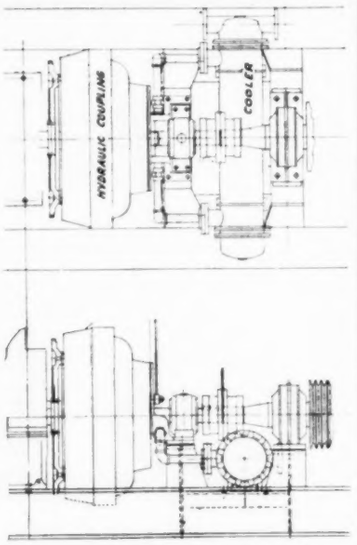


Fig. 1. Sketch of a 30-in. hydraulic coupling of the scoop-control type mounted on flywheel of 6-cylinder gas engine

directly to the flywheel of each engine. The coupling consists fundamentally of the three main elements that comprise a constant-speed traction hydraulic coupling—the impeller, the runner, and the enclosing cover—plus an outer rotating oil reservoir, a fixed manifold, and an adjustable scoop tube. By means of the scoop tube the amount of oil in the working circuit is varied to change the output speed and power. Setting of the position of the scoop tube on this rig was by remote control and was operated from the driller's position on the derrick floor.

The impeller of the hydraulic coupling is radial-vaned and facing it, but not in actual contact, is the similarly vaned runner. The enclosing cover is a part of the impeller and completely envelops the runner so that the runner, in a sense, is situated within the impeller. The impeller is attached to the flywheel of the engine and the runner to the driven shaft. The enclosure formed by the impeller and its cover is filled with oil and the runner rests submerged in this oil.

As the impeller is rotated the centrifugal force throws the oil outward between the radial vanes to the inside periphery of the coupling and the oil, following the curved contour of the impeller, flows directly into the vane runner facing it, delivering its kinetic energy to the runner and flowing back to the center to complete the circuit. This flow is continuous and, inasmuch as it is delivered from a constantly rotating impeller results in torque and rotation of the runner rather than straight axial pressure.

In the scoop-control hydraulic coupling, the outer case acts as an oil reservoir and receives centrifugally the oil that is not required in the circuit to transmit power at any one speed setting. The scoop tube is mounted eccentrically on the stationary manifold and is pivoted so that it can swing through an arc of 82 deg. With the coupling rotating, centrifugal force holds the oil in the outer casing in an annular ring against the outer rim. When the scoop tube is in its outermost position it picks up all the oil in the outer casing, carries it through cored openings of the manifold and into the working circuit to transmit maximum power. When the scoop tube is in the fully retracted position it is completely out of the annular ring of casing oil and carries no oil to the working circuit.

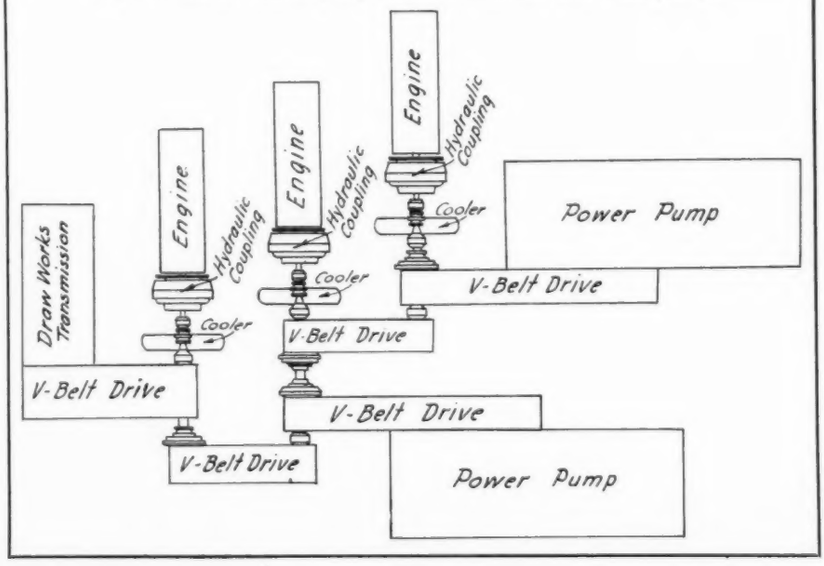
Variation in output speed and power is obtained by setting the scoop tube in any intermediate position between the full dip and fully retracted. This leaves in the outer casing a rim of oil of varying thickness depending on the position of the scoop tube with relation to the outer casing rim.

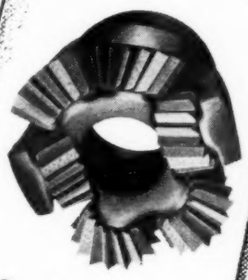
Although the drilling of one well is hardly sufficient service to bring out all the advantages and disadvantages of hydraulic drives, it has demonstrated that such drives can be used to advantage when internal-combustion engines are used as prime movers. In drilling this well it was found that the hydraulic couplings made it possible to approach pump performance comparable to that obtained with a conventional steam pump. That flexibility in application of power was obtained is indicated by the fact that during the operation the two pumps were used singly or in parallel with one engine to each pump, with two engines to one pump, and with the pumps compounded and driven by two engines. The pumps used had sufficient capacity so that circulation during most of the drilling was maintained with one pump driven by two engines in series. Below 9000-ft. depth the mud delivery was approximately 570 gal. per min. against a pressure of 1000 lb. per sq. in. with pumps equipped with 6¾-in. liner and operating at 55 r.p.m.

When used on pump drives, the hydraulic coupling has the important advantage of permitting pressure to be held on the pumps when they are stalled. With the scoop-controlled type as employed on this well it was possible to slip the coupling to any extent desired. This characteristic permits running the engine at its maximum torque speed thereby delivering torque to the pump even while the pump is stalled or running very slowly. Such action is valuable when making casing tests. After the 7-in. string was cemented the mud pump was started-up and a pressure of more than 1000 lb. per sq. in. was maintained with the pump stalled but with the engines running, until the effectiveness of the cement job was believed to have been determined. The same action is advantageous when attempting to establish circulation with mud of great resistance. As the pressure required for circulation decreases and the pumps pick-up speed the scoop control can be regulated to keep the engine at the best running speed until normal operation is obtained.

Pump pressures utilized during the

Fig. 2. Sketch showing layout of drawworks and mud pumps





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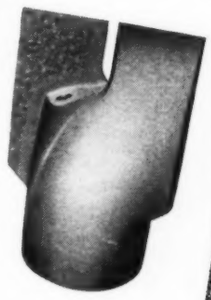

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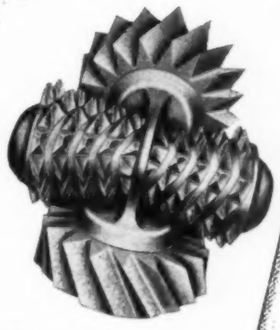

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Simplicity of construction, ease of operation, and dependable surface control are outstanding features contributing to the high efficiency of Globe Wire Line Coring Equipment. The floating inner barrel is securely held down but remains free to stand still with the core and receive it in large unbroken sections. Retrieving the barrel is accomplished quickly and surely by a carefully designed overshot, making it a simple process to drill or core, changing from one to the other with a minimum of delay and without removing the drill string. Inner barrel latches are open to circulating fluid and cannot "sand up". Drag type (soft formation) and roller bearing (hard formation) cutter heads are interchangeable, the latter following the Globe rock bit principle of having cutters supported at both ends.

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drilling of this well varied from just a few pounds after spudding-in to approximately 2000 lb. per sq. in. while drilling. Only the two sizes of liners mentioned, however, were required to cover the entire range of pump performance.

In hoisting from shallow depths, only two of the engines were used but as the well was deepened all three engines were applied in series. The most experienced drillers frequently stall the engines with a conventional drive either through improper synchronization of clutch and throttle or in attempting to lift too great a load. With hydraulic couplings installed it is impossible to stall the engines by overloading. The performance characteristics of these couplings are such that full engine torque is not delivered until they reach a certain speed, which is usually approximately half the rated engine speed. At this point the hydraulic couplings will deliver full engine torque but will slip as much as 100 percent. As the engine speed is increased the slip becomes less until at rated engine speed the slip is between three and four percent.

This action permits the hydraulic coupling to be used as a clutch although in ordinary operation this is not done because of the few seconds' additional time required. In an emergency, however, this feature may be employed successfully. At the other extreme the driller can wait until the hydraulic couplings are at full speed and at minimum slip before engaging the mechanical clutch. If this is done the load may be hoisted with a very rapid acceleration and lifting time is reduced. Obviously the shock involved by this action is great and when repeated often may, in time, cause some damage to the rest of the machinery.

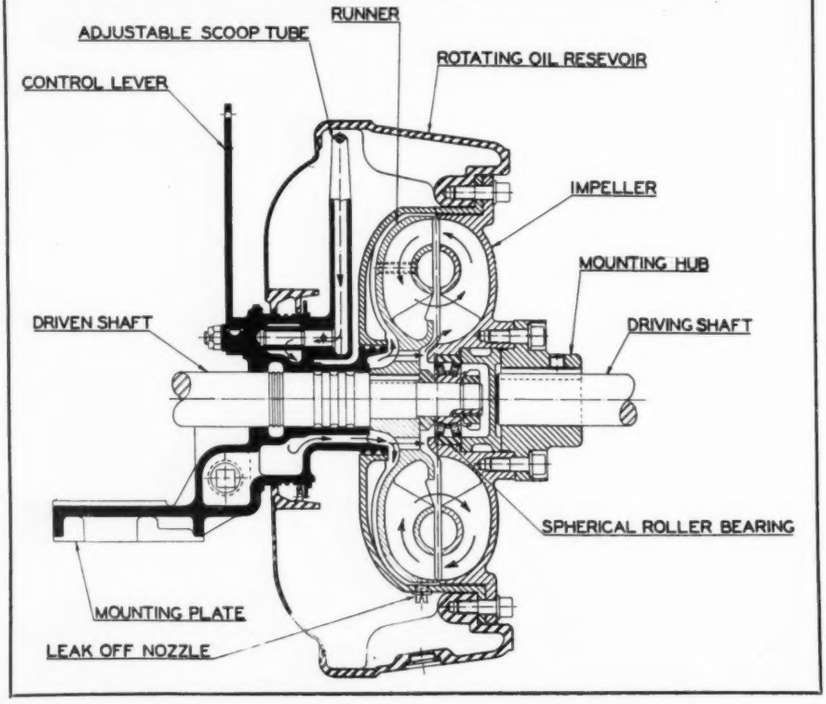
Thus there are disadvantages in following these extreme procedures and the usual practice is to engage the mechanical clutch when the hydraulic couplings are at slightly more than half speed. This action provides a fairly rapid acceleration of the load and, as the couplings are running at a speed where such slip is possible, there is a definite cushioning effect at the time of the shock load. This is attended with considerable ease on the clutch plate. As might be expected when beginning operation of an entirely new type of equipment, the drillers had to become conversant with the performance of the couplings. Hoisting time at first was slow because the loads were applied while the engines were at idling speed. This caused an excessive lag in hoisting but after a time the drillers had become proficient in operating the rig and were adept at speeding the couplings the proper amount to obtain desirable hoisting speed without shock.

During rotation the general practice followed was to use two engines for circulation and one engine for driving the rotary machine. While drilling some formations above 5000 ft., drag bits were used at comparatively high speed and two engines were then applied to rotation. The usual table speed with rock bits ranged between 200 and 300 r.p.m. and one engine was found adequate for this service.

As slippage is a definite feature of the hydraulic coupling the heat generated during slippage must be dissipated. It had previously been determined that the coupling itself will dissipate the heat accompanying approximately 7 to 10 percent slip by convection without the oil becoming dangerously heated. Beyond this amount of slippage the heat generated in the oil induces disintegration and some provision must be made for cooling the oil. This condition occurs frequently with the mud pump drives.

For hoisting alone it is hardly necessary to provide auxiliary cooling units for the oil but the one engine that is always in the hoisting circuit also operates the rotary machine. When hoisting, the instantaneous load is, of course, severe and the slippage may be temporarily great; but the short hoisting cycle is followed immediately by an idling cycle that permits sufficient cooling to offset the overload heating. When driving the rotary table, however, there may be certain occasions in addition to rotating at slow speeds with an attendant limited oil circulation when cooling is required. It was deemed advisable, therefore, to provide cooling for the oil used in all three of the couplings installed on this rig so a cooler of heat exchanger tube type was installed for each of the couplings, as shown in Fig. 1. The cooler is interposed in the oil line from the scoop tube to the working circuit and the pressure developed in the scoop tube is more than sufficient to overcome the oil cooler pressure drop.

Fig. 3. The position of the scoop tube for control of speed and power when using scoop control hydraulic couplings is indicated in this sketch



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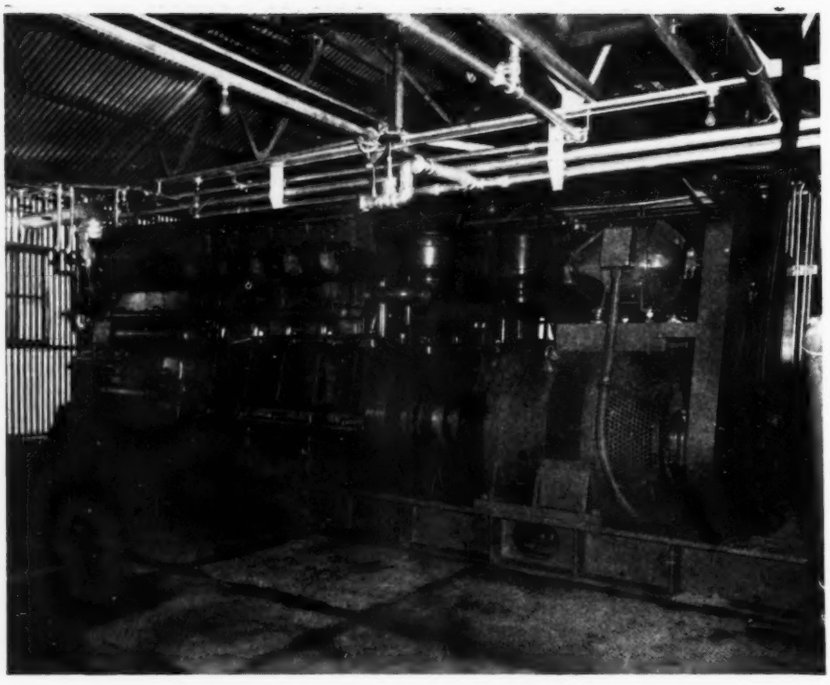


Fig. 1. This engine drives a 200-kw., 900-r.p.m., d-c. generator for oilwell drilling. Belt-driven 25-kw. exciter is mounted directly on generator frame

By
H. E. DRALLE
Manager, Petroleum and Chemical Section, Westinghouse Electric and Manufacturing Company

Use of Electric Power Increases in All Phases of Petroleum Industry

Automatic features of electric installations are used to full advantage in many oil-field and refinery applications

SIGNIFICANT trends and noteworthy engineering advances reflect improved operating economy in all major branches of the petroleum industry during the last year. For example, drilling rigs employed unprecedented power, automatic control now operates wells pumped intermittently, better heat balances have improved refining processes, and cathodic protection is increasingly reducing losses on pipe lines.

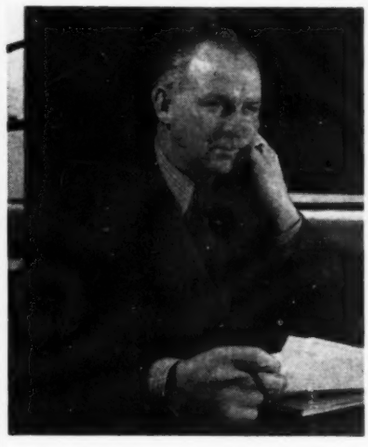
In the producing branch of the oil industry, developments are particularly interesting and have been speeded by more general use of electricity in both drilling and pumping. As a result, operating economy has increased.

Drilling Bit Works More, Loafs Less

Drilling to deeper and deeper depths has necessitated larger prime movers for driving drawworks, to reduce the time taken in going into and coming out of the hole, thus netting more useful time of the bit on bottom. During the year, the capacity of drawworks motors has increased from 400 hp. to 800 hp., and 1000-hp. units are now being considered.

Electric drive has proved particularly suitable for providing increased power for drilling because of its flexibility. For maximum performance, there is a noticeable trend toward the direct current variable voltage system of control. It is mobile, self-contained, and flexible, and on many large rigs the generators are designed to prevent stalling the engine under any operating conditions. (See Fig. 1.) By adding suitable units for parallel operation as well as capacity to the drawworks motor, it is practical to obtain any amount of power for hoisting within the mechanical capacity of the rig. Best practice seems to dictate the use of 1 kw. of generator capacity for each hp. of motors connected, for any operation. A typical drawworks motor with explosion-proof blower for supplying cool, clean, and safe air is shown in Fig. 2.

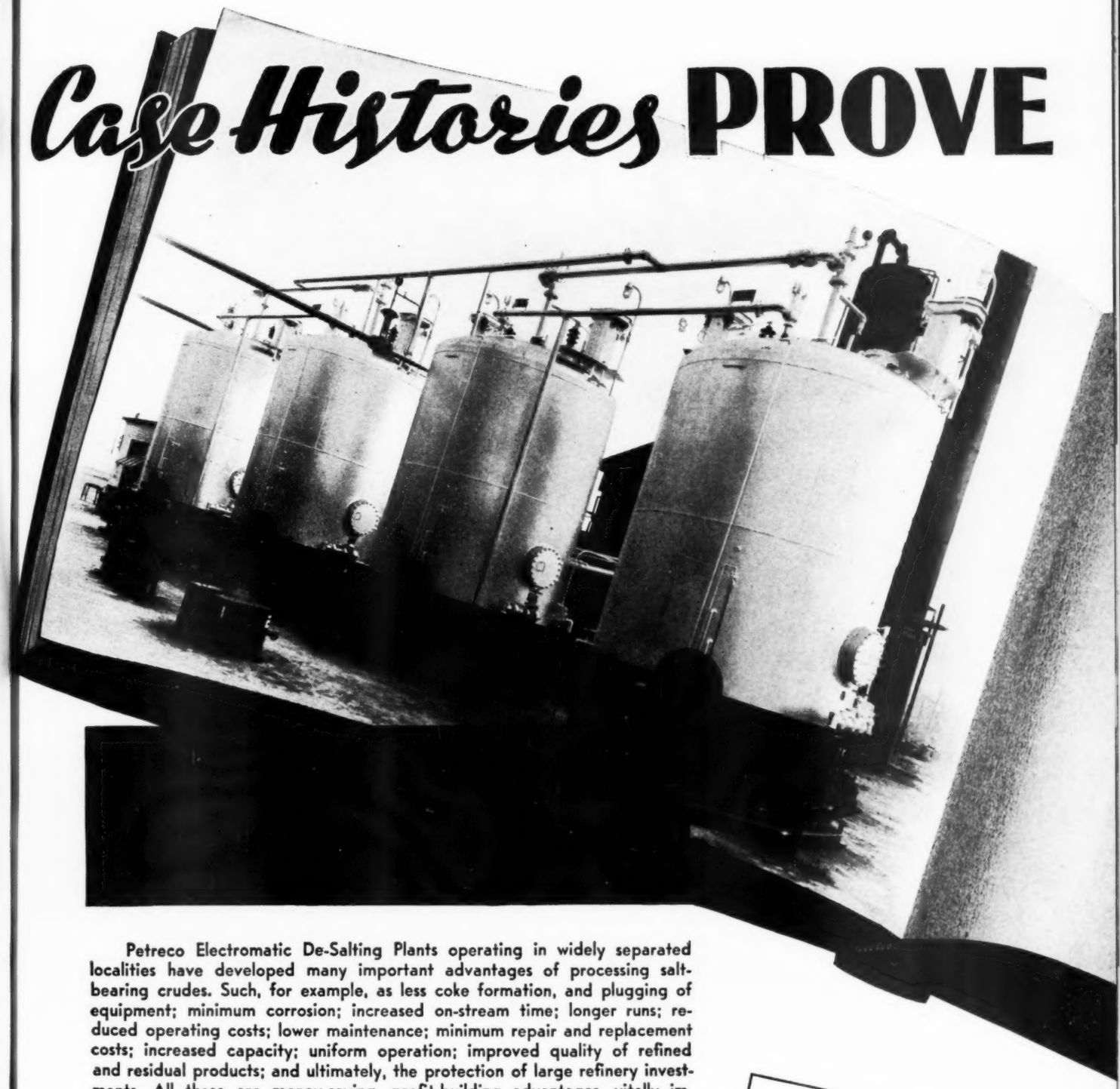
Comparatively simple control segregates the generators to busses supplying power to the mud pump motors or to the busses supplying power to the table or drawworks motor. (See Fig. 3). By means of small master switches, operating on the generator fields, the motors may be brought from zero to



H. E. DRALLE

graduated as an electrical engineer from the University of Illinois in 1916, and since then has been associated continuously with Westinghouse — After general engineering activities, Dralle specialized in the application of electricity to the cement, glass, railroad, and oil industries—In the fall of 1922 he began specializing in oil industry work—As a specialist in the application of electrical machinery to the many phases of the oil industry, he was sent on a trip to the most important oil fields of Europe and the East—This 17 months' trip extended over 37,000 miles and into 26 different countries — Prior to his appointment as manager of the petroleum and chemical section he was gearing representative in the northwestern and southwestern districts for Westinghouse's Nuttall Works.

Case Histories PROVE



Petreco Electromatic De-Salting Plants operating in widely separated localities have developed many important advantages of processing salt-bearing crudes. Such, for example, as less coke formation, and plugging of equipment; minimum corrosion; increased on-stream time; longer runs; reduced operating costs; lower maintenance; minimum repair and replacement costs; increased capacity; uniform operation; improved quality of refined and residual products; and ultimately, the protection of large refinery investments. All these are money-saving, profit-building advantages, vitally important to the most successful refinery operation.

Case histories of numerous Petreco plants, showing how operators have profited by these advantages, will prove intensely interesting to refinery executives and will be supplied on request. Inquiries are invited.

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full speed with a smooth, even flow of power. The flexibility of operation of the drive is comparable to steam, the recognized standard for this control feature. From the standpoints of mobility, fuel cost, and installation expense, it is believed that electric power excels steam even when abundant supplies of suitable water are available for boiler purposes.

Oil sands are constantly being discovered at greater and greater depths, which means that the deeper drilling demands will be met by heavier mechanical equipment and larger capacities in both generators and motors.

When alternating current is used in well drilling, special two-bearing, bracket-type motors have been developed with special torques for mud pump drives. (See Fig. 4). Earlier, common practice for motors rating more than 200 hp. was to use 3-bearing belted parts with a bed plate for the motor and outboard bearing. The portability and installation advantages of the two-bearing bracket-type units are substantial.

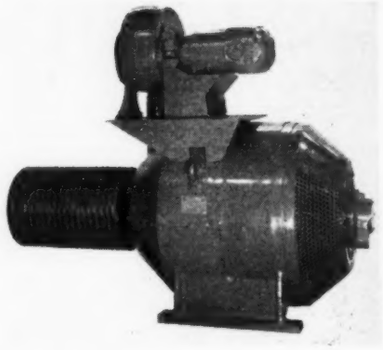


Fig. 4. Special torque characteristics of this 400-hp., 900-r.p.m. d-c. motor safeguard the mud pump

Fig. 2. A 400-hp., 900-r.p.m., d-c. drawworks motor with blower unit driven by explosion-proof motor

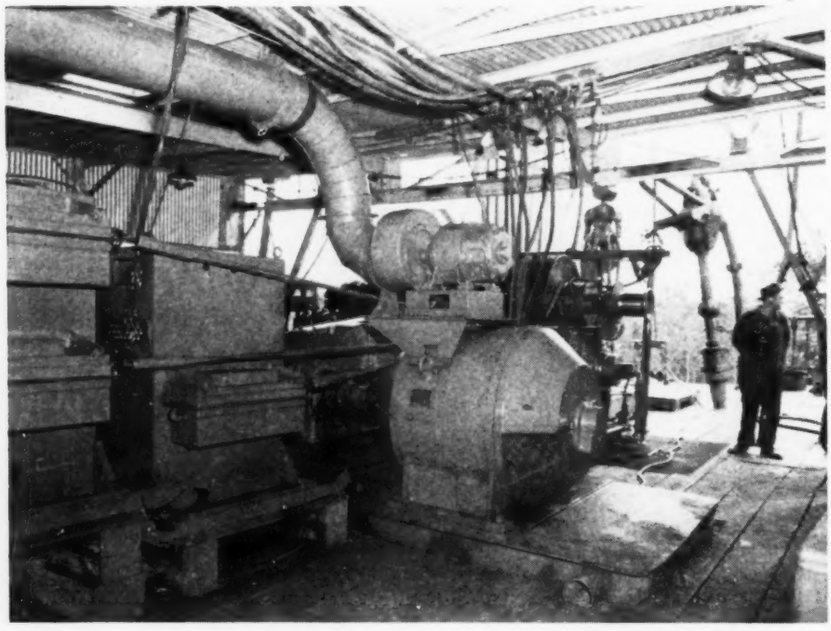
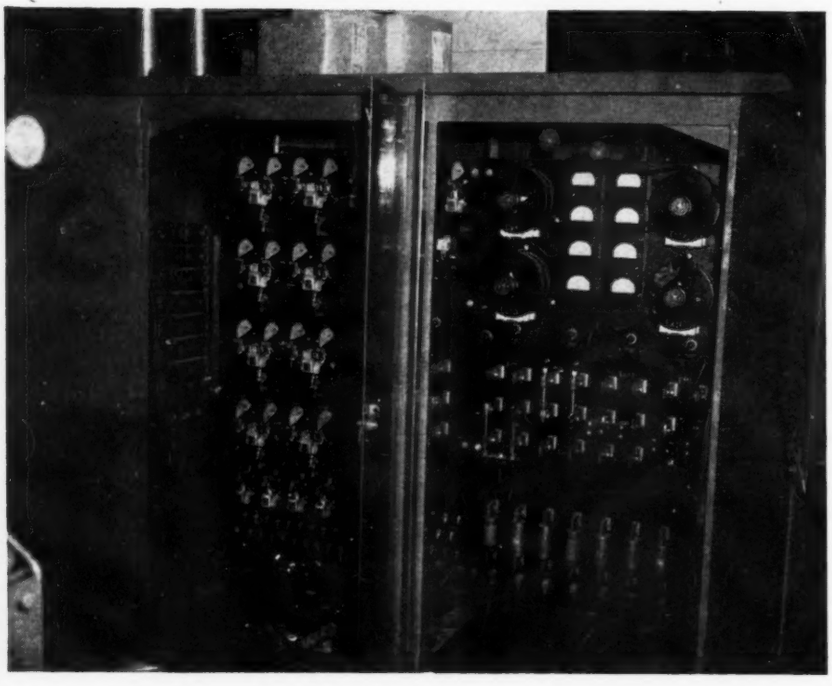


Fig. 3. One of two main control cabinets used with variable voltage oilwell drilling equipment. Total generating capacity of 900 kw. is supplied by four main generators separately excited



The special pull-out torques (1.65 times full load torque) minimize breakage of mechanical parts of pumps either in case of sudden stoppage of the pump discharge or from gradually increasing and excessive pressures.

Pumping Turns to Automatic Control

In oil production using electrified drives, there is a definite trend to automatic pumping by time switch control. This is used not only on wells of small volume requiring occasional operation, but also on wells that are pumped intermittently in compliance with proration schedules.

Time switches can be preset to start and stop wells on any cycle from once each 24 hours to once in each quarter hour. Many pumping units now employ a weatherproof motor and control of the type that utilizes time switch operation, and high-torque motors insure oil-well starting even under adverse weather and well conditions.

When central station power is not available a popular method of obtaining electric power is from a self-contained, engine-driven power unit such as shown in Fig. 5. Capacities range from 3¾ kw. to 250 kw., and from 110 volts to 2300 volts. Instead of being direct-connected, the exciter can be mounted on the generator frame and driven by a "V" belt from the generator shaft. This permits a smaller, higher-speed exciter, decreasing weight and size of the unit.

Improved Heat Balances Aid Refining

Refining processes, shifting to meet constantly changing demands for various products in different quantities

TOMORROW'S FUEL SAFELY STORED

. . . In Welded Steel Tanks—Any Size; Anywhere

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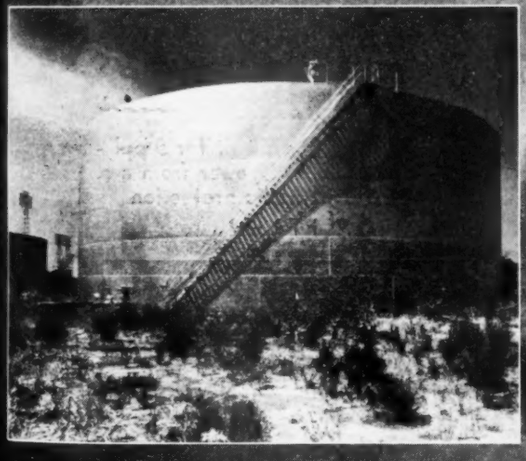
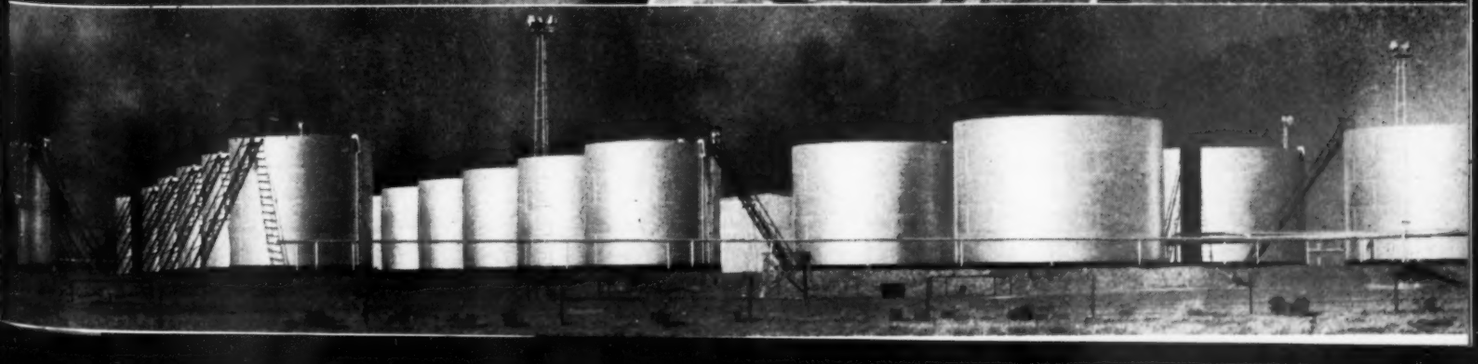




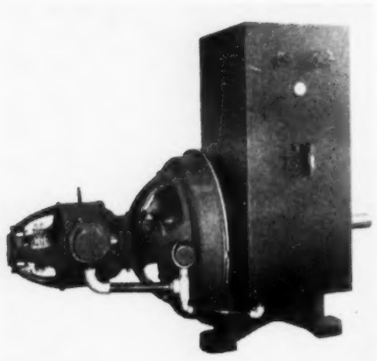
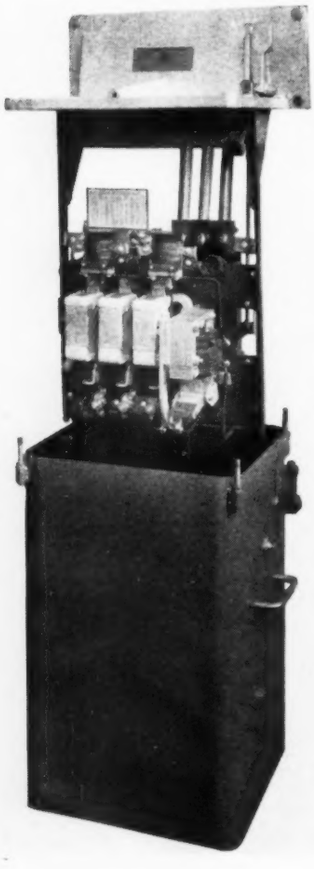


Fig. 5. A 312-kva., 220-v., 1200 r.p.m. ("packaged power") generator, with exciter and complete control

increasingly use latest electrical developments. Noticeable trends have been in the direction of improved heat balances and more carefully engineered drives to net maximum economies.

Where possible to meet these requirements, proved drives have been extended to permit a more diversified use. For example, explosion-proof motors, control, switching, and metering are all now suitable for outdoor application in hazardous and corrosive atmospheres. (See Fig. 6.)

Fig. 6. A 100-hp., 440-v., oil-immersed combination full voltage starter, with circuit breaker for outdoor installation



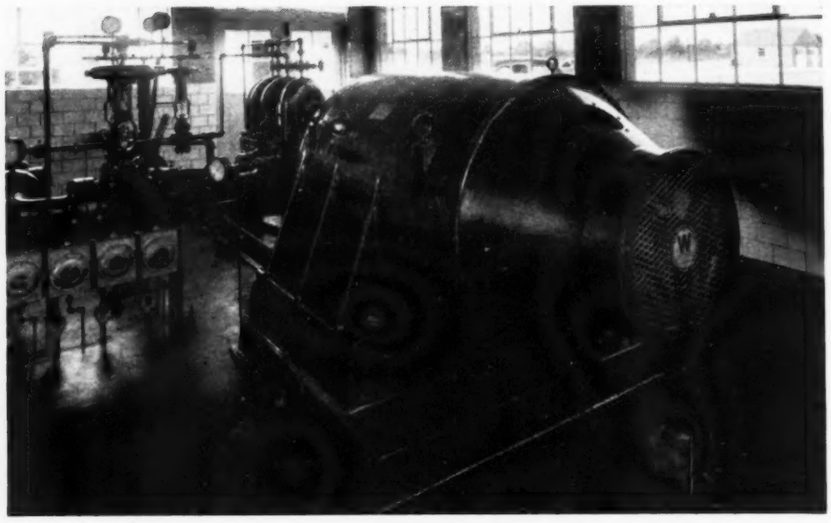


Fig. 7. High-speed "heat-exchanger" motors are popular. This 500-hp., 3600-r.p.m. motor is one of several units in gasoline pipe-line service. The direct-coupled explosion-resisting motor is situated in the pump room

Recycling Plants Powered by Electricity

A recycling plant seems an obvious application for forms of power other than electric drive. When the supply of good water is limited, however, electricity is ideal power, whether obtained from central station sources or from locally operated engine-generator sets. Large installations in the Gulf Coast area during the last two years were almost 100 percent electrified.

The conditions of operation in pipe-line stations affecting the application and utility of electric drives are similar to those in refineries. The use of explosion-resisting drives is increasing. Applications and horsepowers have increased. The simplicity and dependability of dual-ventilated, "heat exchanger" cooling methods for motors are increasingly applied in pipe-line stations, because of overall operating economy. Such drives are practical to 1250 hp. and 3600 r.p.m.

Pipe Lines Stress Cathodic Protection

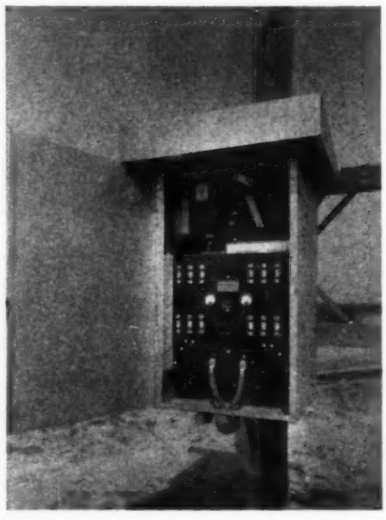
Cathodic protection of lines is receiving increased attention. It has become so important that many companies now have their own departments devoting full time to this work. Others employ consultants to solve their specialized problems.

Weatherproof rectifiers to supply low-voltage direct current from existing a-c. supplies, are being applied. These are compact, efficient, and reliable units serving a useful purpose in cathodic protection of pipe lines.

Tapping New Markets

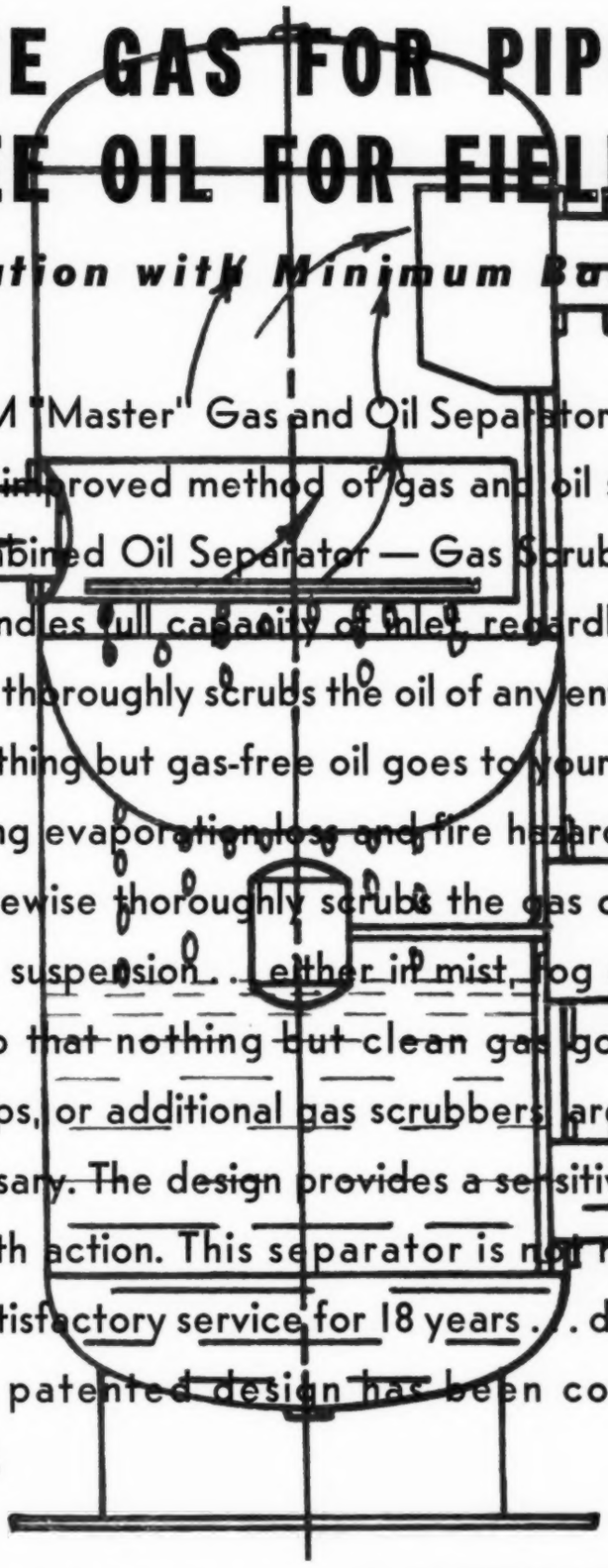
Curtailment of general productive activity in the petroleum industry, principally from losing foreign markets, has intensified the forward-looking efforts of the industry to expand local markets by making economically available to more people the thousands of products derived from petroleum. These results have been accomplished by improved engineering methods and practices within all branches of the industry. And as part of these betterments, electrical developments are increasingly important in all branches of the extensive petroleum industry.

Fig. 8. Pole-mounted unit for supplying low voltage d-c. power from a-c. supply for cathodic protection of pipe line



OIL-FREE GAS FOR PIPE LINES
GAS-FREE OIL FOR FIELD TANKS

True Separation with Minimum Back Pressure



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P 625.4

Spot welding pitted pipe

By
FRANK H. LOVE
Managing Editor

Reconditioning Program Concentrates on "Hot Spots"

Leak reports, other records, and visual inspection of pipe-line right-of-way are basis for indicating sections of line requiring repair.

STANOLIND PIPE LINE COMPANY recently began a program of reconditioning its 8- and 10-in. pipe line between the Mexia station and the Bowie station, Texas. For several years this section of line has been out of use due to the fact that all crude oil from East Texas transported from the East Texas area by Stanolind was sent south to the Pan American refinery at Texas City. Now that Pan American is constructing its own pipe line from East Texas south, Stanolind will move north such East Texas crude oil as is tendered via its line, the ultimate destination being Standard Oil Company's refinery at Whiting, Indiana.

From Mexia station to Bowie station the distance is 184.71 miles. There are four loops in the line, however, which bring the total pipe mileage to 244.61.

The line is not being reconditioned in its entirety but only in "hot spots," determined by leak reports, other records, and visual inspection of the pipe-line right-of-way.

Thus far the reconditioning program has been seriously impeded by excessive rainfall. Mud and water on the right-of-way have enforced idle periods totaling several weeks and the going has been slow at best.

The pipe is being hauled to central yards for conditioning. Initially three yards were established, one near Mexia, one near Hillsboro, and one near Cleburne. As the work progresses these yards will be abandoned and others selected. The general plan is to have a yard as nearly as possible in the center of each 10-mile section so that pipe will not have to be hauled more than an approximate five miles.

The first step in this reconditioning procedure is to determine and mark-off the section of the line to be taken up. After this is done the ditching machines uncover the pipe. Incidentally, all ditchers being used are equipped with cleaners consisting of a set of five steel fingers so placed on the machine that they remove all dirt from the buckets as the wheel rotates. When the pipe is uncovered the collars are torch-cut, enabling tractors equipped with side booms to pick-up the pipe from the ditch and load the sections onto trucks to be transported to the central yard.

Arriving at the yard the pipe is straightened and cleaned before being classified into grades A, B, and junk. Class A pipe is that which needs virtually no reconditioning before it can be reused, Class B stock can be made into usable pipe by a limited amount of spot welding. The junk pipe is to be disposed of at the cleaning yard.

Collars are removed and the ends of all A and B pipe beveled, after which the pipe is double jointed, that is, welded into 40-ft. random lengths. All pits to a depth of 80 mils or greater are then spot welded and the welds ground smooth with emery wheels.

The pipe is then ready to go back to the line where it is electric-welded into the system by the stove-pipe method. Five beads are run—the stringer bead and four finishing welds. With the pipe resting on skids above the trench a traveling-type cleaning machine is employed to remove any dirt that may have adhered to the pipe's surface between the time it was cleaned in the yard and the time it reached the line. In some instances a head is attached to this machine to apply the priming paint, in other instances the primer is applied manually, the procedure adopted depending upon certain circumstances. Following such cleaning and priming a combination coating and wrapping machine of the self-

Beveling pipe in central pipe yard

propelling type now in general use applies Parolite, a hot asphalt coating, to the pipe and then spirally wraps the pipe with asbestos felt. The coating is applied in a thickness of $\frac{5}{32}$ in. This extra thickness is attained by heating the coating to a temperature of 350° F. and providing the machine with two flow nozzles instead of one. The remaining operations are lowering-in of the line, backfilling, and cleaning up.

One exception is made to this general procedure. When short sections of line need reconditioning (usually 200 ft. or less in length) the pipe is coated and wrapped in the central yard where it is cleaned. Pipe for railroad and highway crossings is also coated and wrapped in the yard. The coating of pipe in the central yard is an operation used by Stanolind for the first time.

Creek, highway, and railroad crossings are being replaced with new pipe regardless of the condition of the pipe removed from the line, and in all such instances the pipe is cased, 8-in. pipe with 12-in. casing and 10-in. pipe with 14-in. casing. Casing seal rings are used at each end to close the space between line pipe and casing to exclude moisture. Each crossing is also equipped with gas vents.

The reconditioning work is being done by Stanolind's own operating and construction personnel. Each of the three "gangs" is provided with three 300-amp. welding machines and one 200-amp. machine mounted on a pick-up truck. The latter machine is for cutting collars and running the stringer bead. The other three machines are employed for finishing welds. Each crew also has two trucks and trailers for hauling pipe to and from the cleaning yard; one dragline that is used to dig creek and road crossings, making test holes, and ditching short sections; one 10-ton trailer for moving heavy equipment over highways, and three tractors. The tractors are made virtually all-purpose equipment by being provided with bulldozer blades and booms, enabling their use in backfilling, clearing right-of-way, removing pipe from the trench, and lowering-in.

Although sections of the line to be reconditioned are determined by leak records, as mentioned, to assure that the work is being done thoroughly and that no hot spots are overlooked, test holes are being dug between reconditioned sections so that the condition of the pipe may be accurately known in these areas. This, and the thoroughness with which the pipe is being reconditioned, should repair Stanolind's line between Mexia and Bowie to offset the lack of routine maintenance that was omitted during the several years during which the line was idle.

Making a bell-hole weld. Two welders working together speed-up completion of the weld

Above—Applying coating and asbestos felt to the pipe line by means of a combination coating and wrapping machine

Below—Cleaning machine on stationary base preparing pipe for classifying and welding

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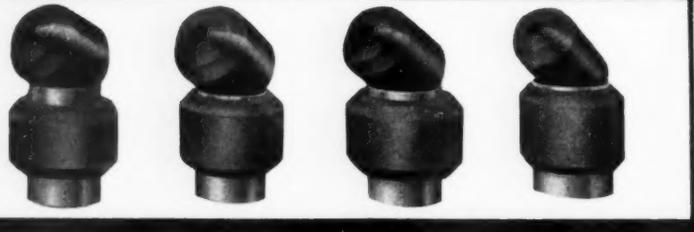

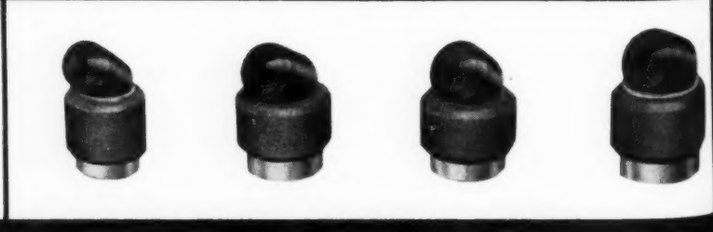

Note the extremely small inside diameter of each size before installation.

THE *Petroleum* Engineer's

CONTINUOUS TABLES

A DAILY REFERENCE FOR OPERATING MEN

INSTALLMENT No. 43

To aid the reader in using the Decimal system of filing, a subject index arranged alphabetically has been published, and is available from *The Petroleum Engineer*.

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FACTORS TO CORRECT OIL VOLUMES FOR TEMPERATURE AND B. S. & W. CONTENT

Temperature, °F.	B. S. & W. content, percent										
	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
60	1.000000	.999000	.998000	.997000	.996000	.995000	.994000	.993000	.992000	.991000	.990000
61	.999600	.998600	.997601	.996601	.995602	.994602	.993602	.992603	.991603	.990604	.989604
62	.999200	.998201	.997202	.996202	.995203	.994204	.993205	.992206	.991206	.990207	.989208
63	.998800	.997801	.996802	.995804	.994805	.993806	.992807	.991808	.990810	.989811	.988812
64	.998400	.997042	.996403	.995405	.994406	.993408	.992410	.991411	.990413	.989414	.988416
65	.998000	.997002	.006004	.995006	.994008	.993010	.992012	.991014	.990016	.989018	.988020
66	.997600	.996602	.995605	.994607	.993610	.992612	.991614	.990617	.989619	.988622	.987264
67	.997200	.996203	.995026	.994208	.993211	.992214	.991217	.990220	.989222	.988225	.9987228
68	.996800	.995803	.994806	.993810	.992813	.991816	.990819	.989822	.988826	.987829	.0986832
69	.996400	.995040	.994407	.993411	.992414	.991418	.990422	.989425	.988429	.987432	.986436
70	.996000	.995004	.994008	.993012	.992016	.991020	.990024	.989028	.988032	.987036	.986040
71	.995600	.994604	.993609	.992613	.991618	.990622	.989626	.988631	.987635	.986640	.985644
72	.995200	.994205	.993210	.992214	.991219	.990224	.989229	.988234	.987238	.986243	.985248
73	.994800	.993805	.992810	.991816	.990821	.989826	.988831	.987836	.986842	.985847	.984852
74	.994400	.993406	.992411	.991417	.990422	.989428	.988434	.987349	.986445	.985450	.984456
75	.994000	.993006	.992012	.991018	.990024	.989030	.988036	.987042	.986048	.985054	.984060
76	.993600	.992606	.991613	.990619	.989626	.988632	.987638	.986645	.985651	.984658	.983664
77	.993200	.992207	.991214	.990220	.989227	.988234	.987241	.986248	.985254	.984261	.983268
78	.992800	.991807	.990814	.989822	.988829	.987836	.986843	.985850	.984858	.983865	.982872
79	.992400	.991408	.990415	.989423	.988430	.987438	.986446	.985453	.984461	.983468	.982476
80	.992000	.991008	.990016	.989024	.988032	.987040	.986048	.985056	.084064	.983072	.982080
81	.991600	.990608	.989617	.988625	.987634	.986642	.985650	.984659	.983667	.982676	.981684
82	.991200	.990209	.989218	.988226	.987235	.986244	.985253	.984262	.983270	.982279	.981288
83	.990800	.989809	.988818	.987828	.986837	.985846	.984855	.983864	.982874	.981883	.980892
84	.990400	.989410	.988419	.987429	.986438	.985448	.984458	.983467	.982477	.981486	.980496
85	.990000	.989010	.988020	.987030	.986040	.985050	.985060	.983070	.982080	.981090	.980100
86	.989600	.988610	.987621	.986631	.985642	.984652	.983662	.982673	.981683	.980694	.979704
87	.989200	.988211	.987222	.986232	.985243	.984254	.983265	.982276	.981286	.980297	.979308
88	.988800	.987811	.986822	.985834	.984845	.983856	.982867	.981878	.980890	.979901	.978912
89	.988400	.987412	.986423	.985435	.984446	.983458	.982470	.981481	.980493	.979504	.978516
90	.988000	.987012	.986024	.085036	.984048	.983060	.982072	.981084	.980096	.979108	.978120
91	.987600	.986612	.985625	.984637	.983650	.982662	.981674	.980687	.979699	.978712	.977724
92	.987200	.986213	.985226	.984238	.983251	.982264	.981277	.980290	.979302	.978315	.977328
93	.986800	.985813	.984826	.983840	.982853	.981866	.980879	.979892	.978906	.977919	.976932
94	.986400	.985414	.984427	.983441	.982454	.981468	.980482	.979495	.978509	.977522	.976536
95	.986000	.098514	.084028	.983042	.982056	.081070	.980084	.979098	.978112	.977126	.976140
96	.985600	.984614	.983629	.982643	.981658	.980672	.979686	.978701	.977715	.976730	.975744
97	.985200	.984215	.983230	.982244	.981259	.980274	.979289	.978304	.977318	.976333	.975348
98	.984800	.983815	.982830	.981846	.980861	.979876	.978891	.977906	.976922	.975937	.974952
99	.984400	.983416	.982431	.981447	.980462	.979478	.978494	.977509	.976525	.975540	.974556
100	.984000	.983016	.982032	.981048	.980064	.979080	.978096	.977112	.976128	.975144	.974160
101	.983600	.982616	.981633	.980649	.979666	.978682	.977698	.976715	.975731	.874748	.973764
102	.983200	.982217	.981234	.980250	.979267	.978284	.977301	.976318	.975334	.974351	.973368
103	.982800	.981817	.980834	.979852	.978869	.977886	.976903	.975920	.974938	.973955	.972972
104	.982400	.981418	.980435	.979453	.978470	.977488	.976506	.975523	.974541	.973558	.972576

The above factors provide for simultaneous adjustment to volumes of dry oil at 60°F. based on observed temperature and percent of B. S. & W. The correction for temperature is based on 1 percent volume change per 25°F. change in temperature.

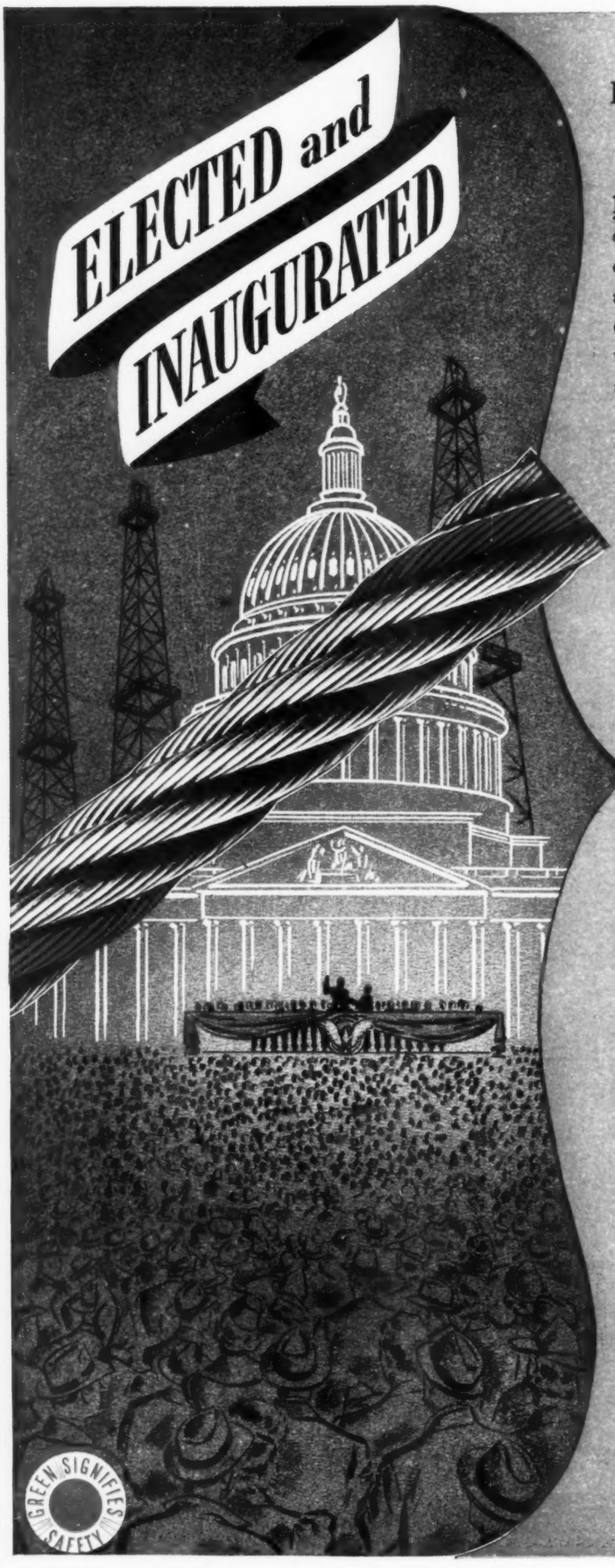
Example: The gauged volume of oil is 25,695 bbl. Actual temperature of the oil is 66°F. and B. S. & W. content is 0.5 percent. What is volume of dry oil at 60°F.?

Solution: From table, factor for 66°F. and 0.5 percent B. S. & W. is 0.992612.

25,695 bbl. × 0.992612 = 25,505 bbl. = volume at 60°F.

Table suggested by K. R. Jones, Sparkman & Reusch Drilling Co., Tulsa, Okla., and made available through the courtesy of Witco Oil & Gas Co., Dallas, Texas.

Sheet 1B
P 677.411.



HAZARD LAY·SET
preformed

'Way back in 1926 Hazard LAY-SET Preformed was elected a chief executive of the rotary drilling industry. And with every succeeding year it has been inaugurated on an ever-increasing number of drilling jobs. It does its work so well that in more than nine times out of ten it succeeds itself. And why not? In Hazard LAY-SET Preformed there are no life-shortening stresses; no cranky resistance. Being preformed, LAY-SET Green Strand Lines are much easier to thread through the traveling block, crown block and eye in the drum. They do not have to be back-twisted; they whip less at high speeds; they spool tightly regardless of load; they make possible faster round trips. Ask your Hazard representative to *prove* the superiority of Hazard LAY-SET Preformed Green Strand.

HAZARD "NONPARELL"
non-preformed

Here's the line that has served all industry *continuously* through three generations—95 years to be exact. In the cable tool fields it is the preferred line because it has the reach—it capably withstands the wear in open hole—and it drills off nicely. Every year more and more cable tool drillers are realizing that Hazard "NONPARELL" gives them more hole per foot of line. And that means real wire line economy. There is greater dollar value in Hazard Wire Lines—and your Hazard representative can prove it. All Hazard Wire Ropes identified by the Green Strand are made of Improved Plow Steel.

HAZARD WIRE ROPE DIVISION
Established 1846
WILKES-BARRE, PENNSYLVANIA
AMERICAN CHAIN & CABLE COMPANY, INC.
Branches or Distributors in All Important Oil Fields

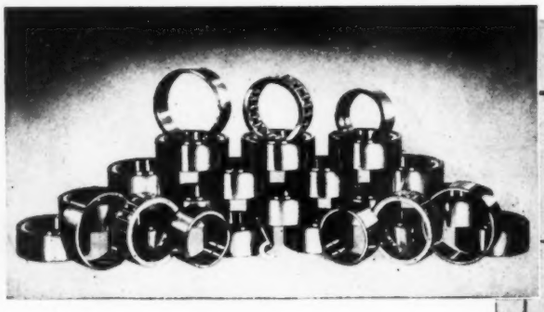
VOLUME IN GAL. OF ACID AND OTHER LIQUIDS CONTAINED IN TUBING STRINGS

Length of tubing ft.	Nominal diameter of tubing, in.								
	1¼	1½	2	2½	3	3	3½	3½	4
	I. D. of tubing, in.								
	1.380	1.610	1.995	2.441	2.992	2.992	3.548	3.476	3.958
7250	563.9	767.3	1178.	1764.	2650.	2528.	3725.	3578.	4636.
7300	567.8	772.6	1186.	1776.	2668.	2545.	3751.	3602.	4668.
7350	571.7	777.9	1194.	1788.	2686.	2563.	3777.	3627.	4700.
7400	575.6	783.1	1203.	1800.	2705.	2580.	3802.	3652.	4732.
7450	579.5	788.4	1211.	1812.	2723.	2597.	3828.	3676.	4764.
7500	583.4	793.7	1219.	1824.	2741.	2615.	3854.	3701.	4796.
7550	587.2	799.0	1227.	1837.	2759.	2632.	3879.	3726.	4828.
7600	591.1	804.3	1235.	1849.	2778.	2650.	3905.	3750.	4860.
7650	595.0	809.6	1243.	1861.	2796.	2667.	3931.	3775.	4892.
7700	598.9	814.9	1251.	1873.	2814.	2685.	3956.	3800.	4924.
7750	602.8	820.2	1259.	1885.	2833.	2702.	3982.	3824.	4956.
7800	606.7	825.5	1268.	1897.	2851.	2719.	4008.	3849.	4988.
7850	610.6	830.8	1276.	1910.	2869.	2737.	4034.	3874.	5020.
7900	614.5	836.1	1284.	1922.	2887.	2754.	4059.	3898.	5052.
7950	618.4	841.3	1292.	1934.	2906.	2772.	4085.	3923.	5084.
8000	622.2	846.6	1300.	1946.	2924.	2789.	4111.	3948.	5116.
8050	626.1	851.9	1308.	1958.	2942.	2807.	4136.	3972.	5148.
8100	630.0	857.2	1316.	1970.	2960.	2824.	4162.	3997.	5180.
8150	633.9	862.5	1324.	1983.	2979.	2841.	4188.	4022.	5212.
8200	637.8	867.8	1333.	1995.	2997.	2859.	4213.	4046.	5244.
8250	641.7	873.1	1341.	2007.	3015.	2876.	4239.	4071.	5276.
8300	645.6	878.4	1349.	2019.	3034.	2894.	4265.	4096.	5308.
8350	649.5	833.7	1357.	2031.	3052.	2911.	4290.	4120.	5340.
8400	653.4	889.0	1365.	2043.	3070.	2929.	4316.	4145.	5372.
8450	657.2	894.3	1373.	2056.	3088.	2946.	4342.	4170.	5404.
8500	661.1	899.6	1381.	2068.	3107.	2963.	4368.	4194.	5436.
8550	665.0	904.8	1389.	2080.	3125.	2981.	4393.	4219.	5469.
8600	668.9	910.1	1398.	2092.	3143.	2981.	4419.	4244.	5500.
8650	672.8	915.4	1406.	2104.	3161.	3016.	4445.	4268.	5532.
8700	676.7	920.7	1414.	2116.	3180.	3033.	4470.	4293.	5564.
8750	680.6	926.0	1422.	2129.	3198.	3051.	4496.	4318.	5596.
8800	684.5	931.3	1430.	2141.	3216.	3068.	4522.	4342.	5628.
8850	688.4	936.6	1438.	2153.	3235.	3085.	4547.	4367.	5659.
8900	692.2	941.9	1446.	2165.	3253.	3103.	4573.	4392.	5691.
8950	696.1	947.2	1454.	2177.	3271.	3120.	4599.	4416.	5723.
9000	700.0	952.5	1463.	2189.	3289.	3138.	4624.	4441.	5755.
9050	703.9	957.8	1471.	2202.	3308.	3155.	4650.	4466.	5787.
9100	707.8	963.1	1479.	2214.	3326.	3173.	4676.	4490.	5819.
9150	711.7	968.3	1487.	2226.	3344.	3190.	4702.	4515.	5851.
9200	715.6	973.6	1495.	2238.	3363.	3207.	4727.	4540.	5883.
9250	719.5	978.9	1503.	2250.	3381.	3225.	4753.	4565.	5915.
9300	723.4	984.2	1511.	2262.	3399.	3242.	4779.	4589.	5947.
9350	727.2	989.5	1519.	2274.	3417.	3260.	4804.	4614.	5979.
9400	731.1	994.8	1528.	2287.	3436.	3277.	4830.	4639.	6011.
9450	735.0	1000.	1536.	2299.	3454.	3295.	4956.	4663.	6043.
9500	739.0	1005.	1544.	2311.	3472.	3312.	4881.	4688.	6075.
9550	743.0	1010.	1552.	2324.	3491.	3329.	4907.	4713.	6107.
9600	746.9	1016.	1560.	2336.	3509.	3347.	4932.	4738.	6139.
9650	750.8	1021.	1568.	2348.	3527.	3364.	4958.	4762.	6171.
9700	754.7	1026.	1576.	2360.	3545.	3381.	4984.	4787.	6203.
9750	758.6	1032.	1584.	2372.	3564.	3399.	5010.	4812.	6235.
9800	762.4	1037.	1593.	3284.	3582.	3416.	5035.	4836.	6267.
9850	766.3	1042.	1601.	2397.	3600.	3434.	5061.	4861.	6299.
9900	770.3	1047.	1609.	2409.	3618.	3451.	5087.	4886.	6331.
9950	774.1	1053.	1617.	2421.	3637.	3469.	5112.	4910.	6363.

For example and notes see sheets 1 and 2, P 532.91

Boosting BLOCK EFFICIENCY

IDECO EQUIPMENT OPERATES SMOOTHLY ON BANTAM BEARINGS



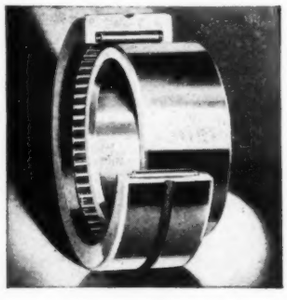
Bantam Journal Roller Bearings are contributing to the excellent performance records established with the crown and traveling blocks built by The International Derrick and Equipment Company. And Bantam Straight Roller Bearings are performing with equal success in Ideco swivels.

These applications are typical of the many ways in which Bantam Bearings are helping to keep costs down and efficiency up in oil well equipment of every type. Bantam engineers cooperate with equipment manufacturers in the recommendation of bearings for the most exacting oil well applications. You can profit by Bantam's cooperation, for Bantam's skill and experience are your assurance that the bearings in your equipment will operate efficiently for long periods of time. Specify Bantam Bearings when you buy equipment.

BANTAM BEARINGS CORPORATION
SOUTH BEND, INDIANA

BANTAM'S ANGULAR CONTACT BEARINGS are widely used for rotary table service. They take both the thrust load and the radial load imposed by driving gear and unbalanced weight, and permit high table speeds.

BANTAM'S QUILL BEARINGS have exceptional performance records in many types of oil well equipment. Typical applications include saddles, equalizers, pitmans on pumping units.



BANTAM'S ENGINEERING COUNSEL is based on comprehensive experience—on thorough knowledge of the performance of *every* type of bearing. For unbiased, authoritative bearing advice, leading makers of oil well equipment TURN TO BANTAM.

BANTAM BEARINGS

STRAIGHT ROLLER • TAPERED ROLLER • NEEDLE • BALL

FACTORS TO CORRECT OIL VOLUMES FOR TEMPERATURE AND B. S. & W. CONTENT

Temperature, °F.	B. S. & W. content, percent									
	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0
60	0.989000	0.988000	0.987000	0.986000	0.985000	0.984000	0.983000	0.982000	0.981000	0.980000
61	.988604	.987605	.986605	.985606	.984606	.983606	.982607	.981607	.980608	.979608
62	.988209	.987210	.986210	.985211	.984212	.983213	.982214	.981214	.980215	.979216
63	.987813	.986814	.985816	.984817	.983818	.982819	.981820	.980822	.979823	.978824
64	.987418	.986419	.985421	.984422	.983424	.982426	.981427	.980429	.979430	.978432
65	.987022	.986024	.985026	.984028	.983030	.982032	.981034	.980036	.979038	.978040
66	.986626	.985629	.984631	.983634	.982636	.981638	.980641	.979643	.978646	.977648
67	.986231	.985234	.984236	.983239	.982242	.981245	.980248	.979250	.978253	.977256
68	.985835	.984838	.983842	.982845	.981848	.980851	.979854	.978858	.977861	.876864
60	.985440	.984443	.983447	.982450	.981454	.980458	.979461	.978465	.977468	.976472
70	.985044	.984048	.983052	.982056	.981060	.980064	.979068	.978072	.977076	.976080
70	.984648	.983653	.982657	.981662	.980666	.979670	.978675	.977679	.976684	.975688
72	.984253	.983258	.982262	.981267	.980272	.979277	.978282	.977286	.976291	.975296
73	.983857	.982862	.981868	.980873	.979878	.978883	.977888	.976894	.975899	.974904
74	.983462	.982467	.981473	.980478	.979484	.978490	.977495	.976501	.975506	.974512
75	.983066	.982072	.981078	.980084	.979090	.978096	.977102	.976108	.975114	.974120
76	.982670	.981677	.980683	.979690	.978696	.977702	.976709	.975715	.974722	.973728
77	.982275	.981282	.980288	.979295	.978302	.977309	.976316	.975322	.974329	.973336
78	.981879	.980886	.979894	.978901	.977908	.976915	.975922	.974930	.973937	.972944
70	.981484	.980491	.979499	.978506	.977514	.976522	.975529	.974537	.973544	.972552
80	.981088	.980096	.979104	.978112	.977120	.976128	.975136	.974144	.973152	.972160
81	.980692	.979701	.978709	.977718	.976726	.975734	.974743	.973751	.972760	.971768
82	.980297	.979306	.978314	.977323	.976332	.975341	.974350	.973358	.972367	.971376
83	.979901	.978910	.977920	.976929	.975938	.974947	.973956	.972966	.971975	.970984
84	.979506	.978515	.977525	.976534	.975544	.974554	.973563	.972573	.971582	.970592
85	.979110	.978120	.977130	.976140	.975150	.974160	.973170	.972180	.971190	.970200
86	.878714	.977725	.976735	.975746	.974756	.973766	.972777	.971787	.970798	.969808
87	.978319	.977330	.976340	.975351	.974362	.973373	.972384	.971394	.970405	.969416
88	.977923	.976934	.975946	.974957	.973968	.972979	.971990	.971002	.970013	.969024
89	.977528	.976539	.975551	.974562	.973574	.972586	.971597	.970609	.969620	.968632
90	.977132	.976144	.975156	.974168	.973180	.972192	.971204	.970216	.9628	.968240
91	.976736	.975749	.974761	.973774	.972786	.971798	.970811	.969823	.968836	.967848
92	.976341	.975354	.974366	.973379	.972392	.971405	.970418	.969430	.968413	.967456
93	.975945	.974958	.973972	.972985	.971998	.971011	.970024	.969038	.968051	.967064
94	.975550	.974563	.973577	.972590	.971604	.970618	.969631	.968645	.967658	.966672
95	.975154	.974168	.973182	.972196	.971210	.970224	.969238	.968252	.967266	.966280
96	.974758	.973773	.972787	.971802	.970816	.969830	.968845	.967859	.966874	.965888
97	.874363	.873378	.972392	.971407	.970422	.969437	.968452	.967466	.966481	.965496
98	.973967	.972982	.971998	.971013	.970028	.969043	.968058	.967074	.966089	.965104
99	.973572	.972587	.971603	.970618	.969634	.968650	.967665	.966681	.965696	.964712
100	.973176	.972192	.971208	.970224	.969240	.968256	.967272	.966288	.965304	.964320
101	.972780	.971797	.970813	.969830	.968846	.967862	.966879	.965895	.964912	.963928
102	.972385	.971402	.970418	.969435	.968452	.967469	.966486	.965502	.964519	.963536
103	.971989	.971006	.970024	.969041	.968058	.967075	.966092	.965110	.964127	.963144
104	.971594	.970611	.969629	.968646	.967664	.966682	.965699	.964717	.963734	.962752

The above factors provide for simultaneous adjustment to volumes of dry oil at 60°F. based on observed temperature and percent of B. S. & W. The correction for temperature is based on 1 percent volume change per 25°F. change in temperature.

Example: The gauged volume of oil is 25,695 bbl. Actual temperature of the oil is 74°F. and B. S. & W. content is 1.6 percent. What is volume of dry oil at 60°F.?

Solution: From table, factor for 74°F. and 1.6 percent B. S. & W. is 0.978490.

25,695 bbl. × 0.978490 = 25,142 bbl. = volume at 60°F.

Table suggested by K. R. Jones, Sparkman & Reusch Drilling Co., Tulsa, Okla., and made available through the courtesy of Witco Oil & Gas Co., Dallas, Texas.

..with Justifiable Confidence

Confidence results from repetition of dependable service—whether the constancy of a lighthouse . . . the safety of a diver's suit . . . or the accuracy of a gun . . .

Through more than thirty years of dependable performance, Hughes Rock Bits have earned the confidence of the Drilling Industry.

Type "5"
Sizes 9⅞"
and larger

Type "OSC-2"
Sizes 5⅞"
and larger

Type "OWS"
Sizes 3¾"
and larger

Type "D"
Sizes 7⅞"
to 12¼"

Type "W-7"
Sizes 5⅜"
and larger

Type "HR"
Sizes 3¾"
and larger

HUGHES TOOL COMPANY HOUSTON TEXAS

SIZES, WEIGHTS, AND STRENGTHS—PLAIN END LINE PIPE

Size O.D., in.	Weight (plain end), lb. per ft.	Symbol	Thickness		Test pressure, lb. per sq. in.		Working pressure, lb. per sq. in. (safety factor 4)		Tons per mi.
			B.W.G. or inches in fractions	Inches in decimals	Lap-weld or seamless grade "A" 50,000-lb. ultimate fiber stress	Seamless grade "B" 60,000-lb. ultimate fiber stress	Lap-weld or seamless grade "A" 50,000-lb. ultimate fiber stress	Seamless grade "B" 60,000-lb. ultimate fiber stress	
16	67.65	H	13/32	.40625	750	850	635	762	178.617
16	**72.71**	**H**	7/16	**.4375**	**800**	**950**	**684**	**820**	**191.970**
16	77.75	H	15/32	.46875	900	1000	732	879	205.270
16	81.96	N	..	.495	950	1100	773	928	216.398
16	**82.77**	**H**	1/2	**.500**	**950**	**1100**	**781**	**938**	**218.515**
16	**92.74**	**N**	9/16	**.5625**	**1100**	**1200**	**879**	**1055**	**244.838**
18	46.45	N	..	.245	400	....	340	....	122.649
18	**47.39**	**L**	1/4	**.250**	**400**	**450**	**347**	**416**	**125.117**
18	49.07	N	3	.259	450	500	360	431	129.555
18	**53.22**	**L**	9/32	**.28125**	**450**	**550**	**391**	**469**	**140.508**
18	53.73	N	2	.284	450	550	394	473	141.860
18	56.71	N	1	.300	500	550	417	500	149.717
18	58.56	N	..	.310	500	600	431	517	154.619
18	**59.03**	**L**	5/16	**.3125**	**500**	**600**	**434**	**521**	**155.844**
18	64.12	N	0	.340	550	650	472	567	169.295
18	**64.82**	**L**	11/32	**.34375**	**550**	**650**	**477**	**573**	**171.127**
18	**70.58**	**L**	3/8	**.375**	**650**	**700**	**521**	**625**	**186.354**
18	76.33	H	13/32	.40625	700	750	564	677	201.527
18	**76.84**	**N**	..	**.409**	**700**	**750**	**568**	**682**	**202.857**
18	**82.06**	**H**	7/16	**.4375**	**750**	**850**	**608**	**729**	**216.641**
18	**87.76**	**H**	11/32	**.46875**	**800**	**900**	**651**	**781**	**231.704**
18	**93.45**	**H**	1/2	**.500**	**850**	**950**	**694**	**833**	**246.710**
18	**104.75**	**N**	9/16	**.5625**	**950**	**1100**	**781**	**938**	**276.588**
20	52.73	L	1/4	.250	400	450	312	375	139.215
20	57.30	N	..	.272	400	450	340	408	151.295
20	**59.23**	**L**	9/32	**.28125**	**400**	**500**	**352**	**421**	**156.369**
20	59.80	N	2	.284	450	500	355	426	157.874
20	63.11	N	1	.300	450	500	375	450	166.634
20	**65.70**	**L**	5/16	**.3125**	**450**	**550**	**391**	**469**	**173.466**
20	71.39	N	0	.340	500	600	425	510	188.469
20	**72.16**	**L**	11/32	**.34375**	**500**	**600**	**430**	**516**	**190.512**
20	**78.59**	**L**	3/8	**.375**	**550**	**650**	**469**	**563**	**207.501**
20	**85.57**	**N**	..	**.409**	**600**	**700**	**511**	**614**	**225.923**
20	**91.40**	**H**	7/16	**.4375**	**650**	**750**	**547**	**656**	**241.314**
20	**97.77**	**H**	15/32	**.46875**	**700**	**800**	**586**	**703**	**258.136**
20	**104.13**	**H**	1/2	**.500**	**750**	**850**	**625**	**750**	**274.905**
20	**116.77**	**N**	9/16	**.5625**	**850**	**950**	**703**	**844**	**308.278**
22	65.23	N	9/32	.28125	400	450	319	383	172.228
22	69.75	N	..	.301	400	450	342	410	184.155
22	**72.38**	**L**	5/16	**.3125**	**450**	**500**	**355**	**426**	**191.091**
22	78.65	N	0	.340	450	550	386	464	207.641
22	**79.50**	**L**	11/32	**.34375**	**450**	**550**	**391**	**469**	**209.895**
22	**86.60**	**L**	3/8	**.375**	**500**	**600**	**426**	**511**	**228.647**
22	92.27	N	..	.400	550	600	455	545	243.608
22	93.69	L	13/32	.40625	550	650	462	554	247.344
22	**100.75**	**L**	7/16	**.4375**	**600**	**700**	**497**	**597**	**265.985**
22	**107.79**	**L**	15/32	**.46875**	**650**	**700**	**533**	**639**	**284.570**
22	**114.81**	**L**	1/2	**.500**	**700**	**750**	**568**	**682**	**303.101**
22	**128.78**	**N**	9/16	**.5625**	**750**	**850**	**639**	**767**	**339.997**
24	71.24	N	9/32	.28125	350	400	292	351	188.089
24	**79.05**	**L**	5/16	**.3125**	**400**	**450**	**326**	**391**	**208.713**
24	83.42	N	..	.330	400	450	344	413	220.236
24	85.91	N	0	.340	450	500	354	425	226.815
24	**86.84**	**L**	11/32	**.34375**	**450**	**500**	**358**	**430**	**229.281**
24	**94.61**	**L**	3/8	**.375**	**450**	**550**	**391**	**469**	**249.794**
24	102.36	L	13/32	.40625	500	600	423	508	270.251
24	**110.09**	**L**	7/16	**.4375**	**550**	**600**	**456**	**547**	**290.656**
24	**117.80**	**L**	15/32	**.46875**	**600**	**650**	**488**	**586**	**311.005**
24	**125.49**	**L**	1/2	**.500**	**650**	**700**	**521**	**625**	**331.296**
24	**140.80**	**N**	9/16	**.5625**	**700**	**800**	**586**	**703**	**371.717**

†This table may be filed under P 622.3, if preferred.

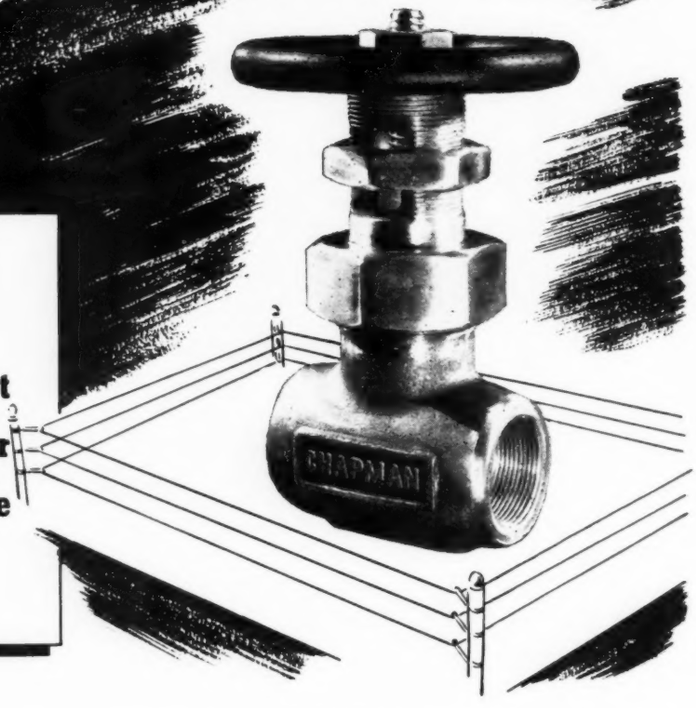
For notes accompanying table see sheet 1 P 615.23†.

Courtesy National Tube Company, Bulletin No. 23.

CHAPMAN CHALLENGER

LIST 960

Invites Economy Test Against Any Other Small Valves For General Oil Industry Service



Match this rugged, forged-steel gate valve against any similar type of valve. See how much longer 960 stands up in service . . . and how it puts a stop to the usual need for constant repairs and replacements.

Chapman List 960 is made in sizes from ¼" to 2" . . . for all pressures up to 800 lb. at 750° . . . and for cold working pressures up to 1500 lb. Both rising-stem models (outside and inside screw) have threaded ends . . . and interchangeable stem, wedge and seat-rings of super-hardened stainless steel. Test Chapman's 960 on *your* small field and refinery lines . . . and your cost-records will show you that this is the valve to standardize on.

The CHAPMAN VALVE MANUFACTURING COMPANY
INDIAN ORCHARD, MASSACHUSETTS

SAPONIFICATION NUMBERS—OILS CONTAINING MORE THAN 30% FATTY OILS—METHOD A

D = 25.0 to 29.9

Value of D[1]	Weight of oil sample, w, grams.																				
	4.90	4.91	4.92	4.93	4.94	4.95	4.96	4.97	4.98	4.99	5.00	5.01	5.02	5.03	5.04	5.05	5.06	5.07	5.08	5.09	5.10
25.0	143.	143.	143.	142.	142.	142.	141.	141.	141.	141.	140.	140.	140.	139.	139.	139.	139.	138.	138.	138.	138.
25.1	144.	143.	143.	143.	143.	142.	142.	142.	141.	141.	141.	141.	140.	140.	140.	139.	139.	139.	139.	138.	138.
25.2	144.	144.	144.	143.	143.	143.	143.	142.	142.	142.	141.	141.	141.	141.	140.	140.	140.	139.	139.	139.	139.
25.3	145.	145.	144.	144.	144.	143.	143.	143.	143.	142.	142.	142.	141.	141.	141.	141.	140.	140.	140.	139.	139.
25.4	145.	145.	145.	145.	144.	144.	144.	143.	143.	143.	142.	142.	142.	142.	141.	141.	141.	141.	140.	140.	140.
25.5	146.	146.	145.	145.	145.	145.	144.	144.	144.	143.	143.	143.	142.	142.	142.	142.	141.	141.	141.	141.	140.
25.6	147.	146.	146.	146.	145.	145.	145.	144.	144.	144.	144.	143.	143.	143.	142.	142.	142.	142.	141.	141.	141.
25.7	147.	147.	147.	146.	146.	146.	145.	145.	145.	144.	144.	144.	144.	143.	143.	143.	142.	142.	142.	142.	141.
25.8	148.	147.	147.	147.	146.	146.	146.	146.	145.	145.	145.	144.	144.	144.	144.	143.	143.	143.	142.	142.	142.
25.9	148.	148.	148.	147.	147.	147.	146.	146.	146.	146.	145.	145.	145.	144.	144.	144.	144.	143.	143.	143.	142.
26.0	149.	149.	148.	148.	148.	147.	147.	147.	146.	146.	146.	146.	145.	145.	145.	144.	144.	144.	144.	143.	143.
26.1	149.	149.	149.	149.	148.	148.	148.	147.	147.	147.	146.	146.	146.	146.	145.	145.	145.	144.	144.	144.	144.
26.2	150.	150.	149.	149.	149.	148.	148.	148.	148.	147.	147.	147.	146.	146.	146.	146.	145.	145.	145.	144.	144.
26.3	151.	150.	150.	150.	149.	149.	149.	148.	148.	148.	148.	147.	147.	147.	146.	146.	146.	146.	145.	145.	145.
26.4	151.	151.	151.	150.	150.	150.	149.	149.	149.	148.	148.	148.	148.	147.	147.	147.	146.	146.	146.	145.	145.
26.5	152.	151.	151.	151.	150.	150.	150.	150.	149.	149.	149.	148.	148.	148.	147.	147.	147.	147.	146.	146.	146.
26.6	152.	152.	152.	151.	151.	151.	150.	150.	150.	150.	149.	149.	149.	148.	148.	148.	147.	147.	147.	147.	146.
26.7	153.	153.	152.	152.	152.	151.	151.	151.	150.	150.	150.	149.	149.	149.	149.	148.	148.	148.	147.	147.	147.
26.8	153.	153.	153.	152.	152.	152.	152.	151.	151.	151.	150.	150.	150.	149.	149.	149.	149.	148.	148.	148.	147.
26.9	154.	154.	153.	153.	153.	152.	152.	152.	152.	151.	151.	151.	150.	150.	150.	149.	149.	149.	149.	148.	148.
27.0	155.	154.	154.	154.	153.	153.	153.	152.	152.	152.	151.	151.	151.	151.	150.	150.	150.	149.	149.	149.	149.
27.1	155.	155.	155.	154.	154.	154.	153.	153.	153.	152.	152.	152.	151.	151.	151.	151.	150.	150.	150.	149.	149.
27.2	156.	155.	155.	155.	154.	154.	154.	154.	153.	153.	153.	152.	152.	152.	151.	151.	151.	150.	150.	150.	150.
27.3	156.	156.	156.	155.	155.	155.	154.	154.	154.	153.	153.	153.	153.	152.	152.	152.	151.	151.	151.	150.	150.
27.4	157.	157.	156.	156.	156.	155.	155.	155.	154.	154.	154.	153.	153.	153.	152.	152.	152.	152.	151.	151.	151.
27.5	157.	157.	157.	156.	156.	156.	156.	155.	155.	155.	154.	154.	154.	153.	153.	153.	152.	152.	152.	152.	151.
27.6	158.	158.	157.	157.	157.	156.	156.	156.	155.	155.	155.	155.	154.	154.	154.	153.	153.	153.	152.	152.	152.
27.7	159.	158.	158.	158.	157.	157.	157.	156.	156.	156.	155.	155.	155.	154.	154.	154.	154.	153.	153.	153.	152.
27.8	159.	159.	158.	158.	158.	158.	157.	157.	157.	156.	156.	156.	155.	155.	155.	154.	154.	154.	154.	153.	153.
27.9	160.	159.	159.	159.	158.	158.	158.	157.	157.	157.	157.	156.	156.	156.	155.	155.	155.	154.	154.	154.	153.
28.0	160.	160.	160.	159.	159.	159.	158.	158.	158.	157.	157.	157.	156.	156.	156.	156.	155.	155.	155.	154.	154.
28.1	161.	161.	160.	160.	160.	159.	159.	159.	158.	158.	158.	157.	157.	157.	156.	156.	156.	155.	155.	155.	155.
28.2	161.	161.	161.	160.	160.	160.	159.	159.	159.	159.	158.	158.	158.	157.	157.	157.	156.	156.	156.	155.	155.
28.3	162.	162.	161.	161.	161.	160.	160.	160.	159.	159.	159.	158.	158.	158.	158.	157.	157.	157.	156.	156.	156.
28.4	163.	162.	162.	162.	161.	161.	161.	160.	160.	160.	159.	159.	159.	158.	158.	158.	157.	157.	157.	157.	156.
28.5	163.	163.	162.	162.	162.	162.	161.	161.	161.	160.	160.	160.	159.	159.	159.	158.	158.	158.	157.	157.	157.
28.6	164.	163.	163.	163.	162.	162.	162.	161.	161.	161.	160.	160.	160.	159.	159.	159.	159.	158.	158.	158.	157.
28.7	164.	164.	164.	163.	163.	163.	162.	162.	162.	161.	161.	161.	160.	160.	160.	159.	159.	159.	158.	158.	158.
28.8	165.	165.	164.	164.	164.	163.	163.	163.	162.	162.	162.	161.	161.	161.	160.	160.	160.	159.	159.	159.	158.
28.9	165.	165.	165.	164.	164.	164.	163.	163.	163.	162.	162.	162.	161.	161.	161.	161.	160.	160.	160.	159.	159.
29.0	166.	166.	165.	165.	165.	164.	164.	164.	163.	163.	163.	162.	162.	162.	161.	161.	161.	160.	160.	160.	160.
29.1	167.	166.	166.	166.	165.	165.	165.	164.	164.	164.	163.	163.	163.	162.	162.	162.	161.	161.	161.	160.	160.
29.2	167.	167.	166.	166.	166.	165.	165.	165.	164.	164.	164.	163.	163.	163.	163.	162.	162.	162.	161.	161.	161.
29.3	168.	167.	167.	167.	166.	166.	166.	165.	165.	165.	164.	164.	164.	163.	163.	163.	162.	162.	162.	161.	161.
29.4	168.	168.	168.	167.	167.	167.	166.	166.	166.	165.	165.	165.	164.	164.	164.	163.	163.	163.	162.	162.	162.
29.5	169.	169.	168.	168.	168.	167.	167.	166.	166.	166.	165.	165.	165.	165.	164.	164.	164.	163.	163.	163.	162.
29.6	169.	169.	169.	168.	168.	168.	167.	167.	167.	166.	166.	166.	165.	165.	165.	164.	164.	164.	163.	163.	163.
29.7	170.	170.	169.	169.	169.	168.	168.	168.	167.	167.	167.	166.	166.	166.	165.	165.	165.	164.	164.	164.	163.
29.8	171.	170.	170.	170.	169.	169.	169.	168.	168.	168.	167.	167.	167.	166.	166.	166.	165.	165.	165.	164.	164.
29.9	171.	171.	170.	170.	170.	169.	169.	169.	168.	168.	168.	167.	167.	167.	166.	166.	166.	165.	165.	165.	164.

[1] D = difference between the number of milliliters of 0.5*N* HCl required for the determination and the average of the two blanks run on the alcoholic potassium hydroxide solution.

The above saponification numbers are calculated by the formula: $\text{Saponification number} = \frac{D \times 28.05}{w}$

This formula is from "Test for Saponification Number," A.S.T.M. (D94-39T).

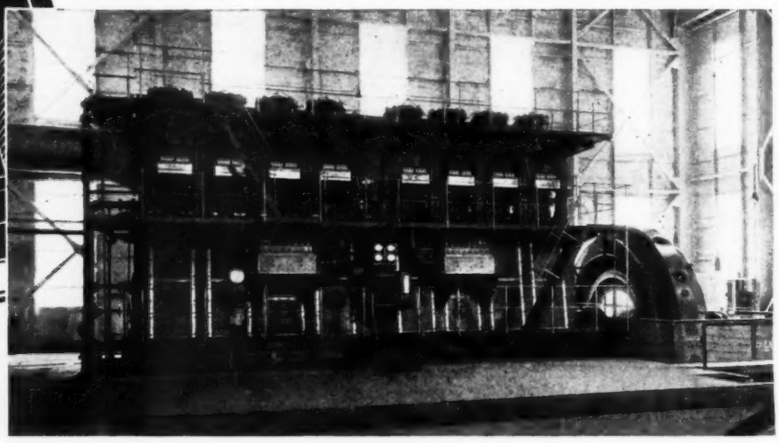
For additional notes, see tables indexed P 747.501.10.

5,824,000,000 HORSEPOWER PACKING HOURS

without a packing bill!

One of two 7,000 horsepower Double-Acting Diesel Engines operated by a western company that depends on COOK'S Metallic Rod Packings for uninterrupted and efficient service.

Case History 40-P-32D



Photograph courtesy General Machinery Corporation

. . . Another tough job . . . another great record for COOK'S METALLIC PACKING

HIDDEN in the lower cylinder heads of these two 7,000 hp. Double-Acting Diesels are the comparatively simple yet all important Metallic Rod Packings which make this style of engine commercially practical.

Day after day, year in and year out these packings take a terrific beating as the oil charge is ignited and an inferno breaks loose on each piston stroke. Yet already these packings have gone 5,824,000,000 hp. packing hours without a cent for replacements.

This characteristic performance is the reason why COOK'S Packings have been selected for every Double-Acting Diesel built in this country. The engines and compressors you operate may present no such severe demands, yet you can reduce your packing bills and increase the efficiency of your machines by utilizing the materials and experience that have made COOK'S Metallic Packings the choice of the leading builders and operators of engines and compressors for over fifty years.

You can do this on ordering new engines and compressors by simply specifying the rods be fitted with COOK'S Packings. For existing equipment consult the COOK'S representative in your territory, or write us direct.

"It pays to use COOK'S METALLIC PACKING"

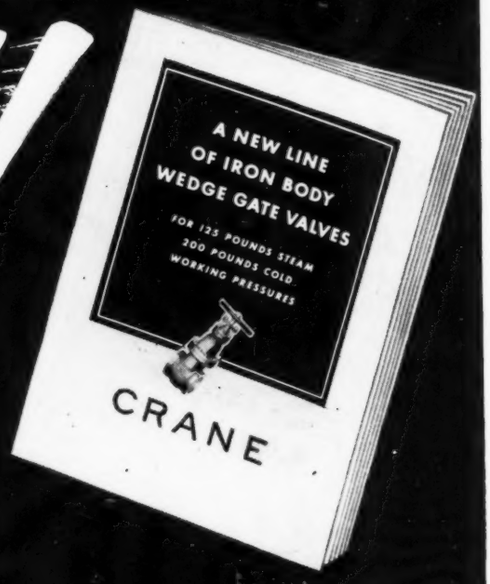
C. LEE COOK MANUFACTURING CO.
INCORPORATED
New York Cleveland Los Angeles Baltimore LOUISVILLE, KY. Chicago Tulsa New Orleans San Francisco

SIZES, WEIGHTS, AND STRENGTHS—PLAIN END LINE PIPE

Size O.D., in.	Weight (plain end), lb. per ft.	Symbol	Thickness		Test pressure, lb. per sq. in.		Working pressure, lb. per sq. in. (safety factor 4)		Tons per mi.
			B.W.G. or inches in fractions	Inches in decimals	Lap-weld or seamless grade "A" 50,000-lb. ultimate fiber stress	Seamless grade "B" 60,000-lb. ultimate fiber stress	Lap-weld or seamless grade "A" 50,000-lb. ultimate fiber stress	Seamless grade "B" 60,000-lb. ultimate fiber stress	
13	40.69	N	1	.300	700	....	577	....	107.424
13	42.01	N	..	.310	700	....	596	....	110.916
13	42.34	N	5/16	.3125	700	....	601	....	111.790
13	43.33	N	..	.320	750	....	615	....	114.404
13	45.97	N	0	.340	800	....	654	....	121.363
13	46.46	N	11/32	.34375	800	....	661	....	122.664
13	48.46	N	..	.359	850	....	690	....	127.952
13	48.73	N	..	.361	850	....	694	....	128.647
13	50.56	N	3/8	.375	850	....	721	....	133.486
13	52.52	N	..	.390	900	....	750	....	138.660
13	58.69	N	7/16	.4375	1000	....	841	....	154.965
13	66.75	N	1/2	.500	1200	....	962	....	176.220
14	30.92	N	..	.210	450	....	375	....	81.649
14	32.19	N	7/32	.21875	450	....	391	....	84.997
14	32.37	N	5	.220	450	....	393	....	85.475
14	34.98	N	4	.238	500	....	425	....	92.349
14	36.42	N	..	.248	550	....	443	....	96.159
14	**36.71**	**L**	1/4	**.250**	**550**	**600**	**446**	**535**	**96.922**
14	38.00	N	3	.259	550	650	463	555	100.343
14	**40.45**	**N**	..	**.276**	**600**	**650**	**493**	**591**	**106.798**
14	41.20	L	9/32	.28125	600	700	502	603	108.789
14	41.60	N	2	.284	600	700	507	609	109.829
14	43.89	N	1	.300	650	750	536	643	115.882
14	45.32	N	..	.310	650	750	554	664	119.658
14	**45.68**	**L**	5/16	**.3125**	**650**	**750**	**558**	**670**	**120.600**
14	47.89	N	..	.328	700	800	586	703	126.440
14	49.60	N	0	.340	750	850	607	729	130.949
14	50.13	L	11/32	.34375	750	850	614	737	132.359
14	**54.56**	**H**	3/8	**.375**	**800**	**900**	**670**	**804**	**144.059**
14	58.98	H	13/32	.40625	850	1000	725	871	155.707
14	**63.37**	**H**	7/16	**.4375**	**950**	**1100**	**781**	**938**	**167.299**
14	**67.74**	**H**	15/32	**.46875**	**1000**	**1100**	**837**	**1004**	**178.836**
14	**72.09**	**H**	1/2	**.500**	**1100**	**1200**	**893**	**1071**	**190.320**
15	35.03	N	..	.222	450	....	370	....	92.500
15	37.52	N	4	.238	500	....	397	....	99.060
15	39.38	N	1/4	.250	500	....	417	....	103.971
15	40.77	N	3	.259	500	....	432	....	107.646
15	40.93	N	..	.260	500	....	433	....	108.055
15	44.21	N	9/32	.28125	550	....	469	....	116.719
15	44.63	N	2	.284	550	....	473	....	117.839
15	45.71	N	..	.291	600	....	485	....	120.684
15	47.09	N	1	.300	600	....	500	....	124.341
15	49.02	N	5/16	.3125	650	....	521	....	129.412
15	50.17	N	..	.320	650	....	533	....	132.451
15	53.23	N	0	.340	700	....	567	....	140.537
15	53.80	N	11/32	.34375	700	....	573	....	142.050
15	58.57	N	3/8	.375	750	....	625	....	154.632
15	63.31	N	13/32	.40625	800	....	677	....	167.162
15	68.04	N	7/16	.4375	900	....	729	....	179.636
15	72.74	N	15/32	.46875	950	....	781	....	192.054
15	77.43	N	1/2	.500	1000	....	833	....	204.417
15	86.73	N	9/16	.5625	1100	....	938	....	228.977
16	39.40	N	..	.234	450	....	366	....	104.018
16	40.06	N	4	.238	450	....	372	....	105.771
16	**42.05**	**L**	1/4	**.250**	**450**	**550**	**391**	**468**	**111.019**
16	43.54	N	3	.259	500	550	405	485	114.950
16	45.35	N	..	.270	500	550	422	506	119.747
16	**47.21**	**L**	9/32	**.28125**	**550**	**600**	**439**	**527**	**124.647**
16	47.66	N	2	.284	550	600	444	533	125.846
16	50.30	N	1	.300	550	650	469	563	132.799
16	**50.63**	**N**	..	**.302**	**550**	**650**	**472**	**566**	**133.668**
16	**52.35**	**L**	5/16	**.3125**	**600**	**650**	**488**	**586**	**138.222**
16	55.22	N	..	.330	600	700	516	619	145.801
16	56.86	N	0	.340	650	700	531	638	150.123
16	**57.47**	**L**	11/32	**.34375**	**650**	**750**	**537**	**645**	**151.741**
16	**62.57**	**H**	3/8	**.375**	**700**	**800**	**586**	**703**	**165.208**
16	**66.80**	**N**	..	**.401**	**750**	**850**	**627**	**752**	**176.367**

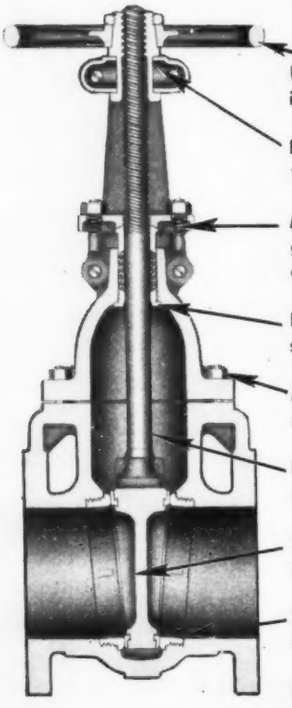
†This table may be filed under P 622.3, if preferred.
For notes accompanying table see sheet 1 P 615.23†.
Courtesy National Tube Company, Bulletin No. 23.

FLASH!



A new and complete line of Crane Iron Body Wedge Gate Valves for 125 pounds steam, 200 pounds cold working pressures. No increase in price. Improved design features extend adaptability for service and assure long trouble-free life under severest conditions. Complete specifications in catalog available from your Crane Representative or by mail request.

NEW FEATURES LIKE THESE IN ALL PATTERNS

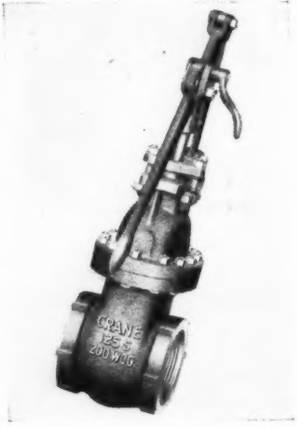


- Unbreakable malleable iron handwheel.
- Easy lubrication fitting in yoke sleeve.
- Malleable iron ball-type gland flange with swing eye bolts.
- Renewable shoulder-type stem hole bushing.
- More bolts of smaller diameter in body-bonnet joint.
- Full length "V-section" disc guides.
- Solid web-type disc with tee-head stem connection.
- Straight through ports. Renewable seat rings.
- Brass trimmed or All-Iron

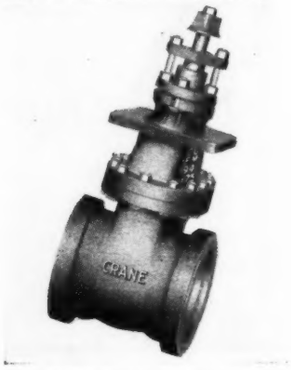
OUTSIDE SCREW AND YOKE
Screwed and flanged ends. Also in alloy cast iron, flanged ends

INSIDE SCREW, NON-RISING STEM
Screwed, flanged, hub ends

MARINE CARGO SYSTEM VALVES
Flanged ends



QUICK-OPENING TYPE
Screwed and flanged ends



UNDERWRITERS' PATTERNS
Screwed, flanged, hub ends

CRANE

CRANE CO., GENERAL OFFICES:
836 S. MICHIGAN AVE., CHICAGO

VALVES • FITTINGS • PIPE
PLUMBING • HEATING • PUMPS

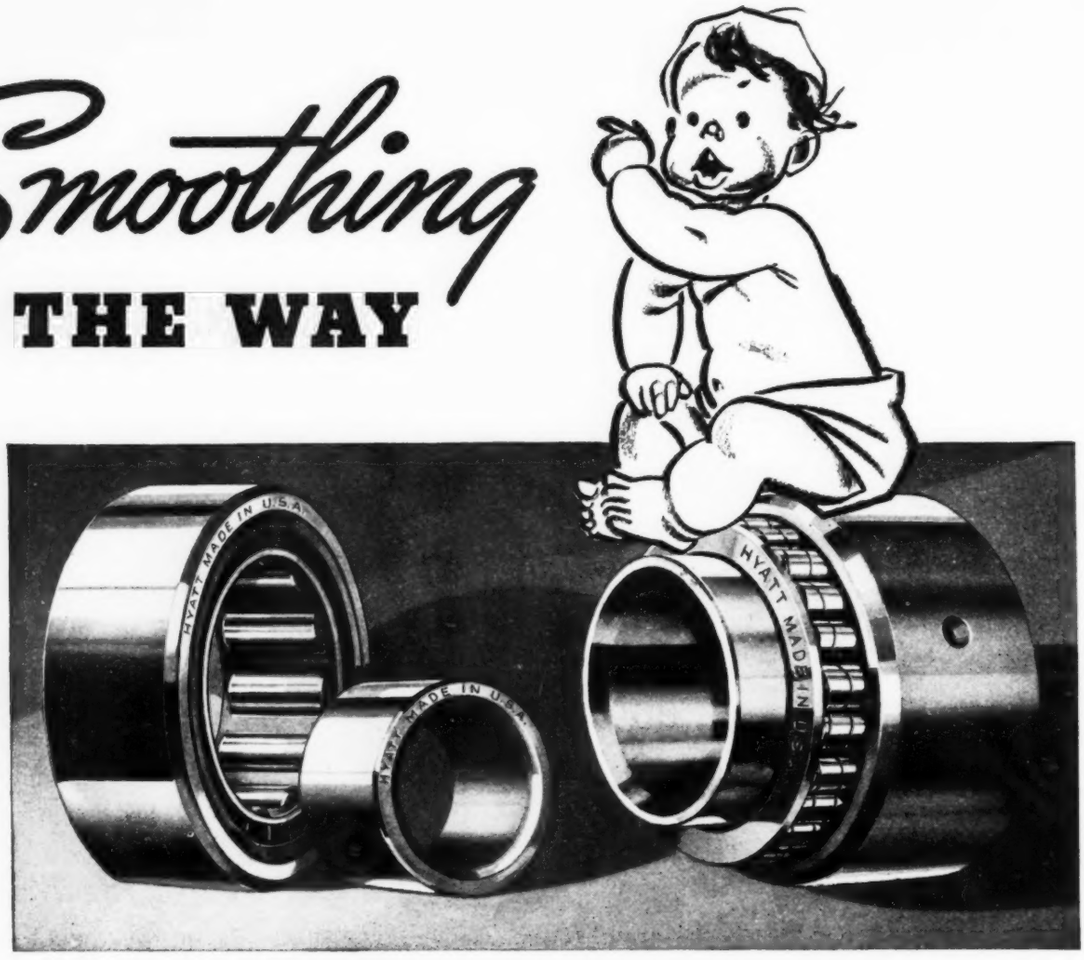
NATION-WIDE SERVICE THROUGH BRANCHES AND WHOLESALERS IN ALL MARKETS

VOLUME IN GAL. OF ACID AND OTHER LIQUIDS CONTAINED IN TUBING STRINGS

Length of tubing ft.	Nominal diameter of tubing, in.								
	1¼	1½	2	2½	3	3	3½	3½	4
	I. D. of tubing, in.								
	1.380	1.610	1.995	2.441	2.992	2.992	3.548	3.476	3.958
4500	350.0	476.2	731.3	1095.	1645.	1596.	2312.	2221.	2878.
4550	353.9	481.5	739.4	1107.	1663.	1586.	2338.	2245.	2910.
4600	357.8	486.8	747.5	1119.	1681.	1604.	2364.	2270.	2942.
4650	361.7	492.1	755.7	1131.	1700.	1621.	2389.	2295.	2974.
4700	365.6	497.4	763.8	1142.	1718.	1639.	2415.	2319.	3006.
4750	369.5	502.7	771.9	1155.	1736.	1656.	2442.	2344.	3038.
4800	373.3	508.0	780.0	1168.	1754.	1673.	2466.	2369.	3070.
4850	377.2	513.3	788.2	1180.	1773.	1691.	2492.	2393.	3102.
4900	381.1	518.6	796.3	1192.	1791.	1708.	2518.	2418.	3134.
4950	385.0	523.9	804.4	1204.	1809.	1726.	2543.	2443.	3165.
5000	388.9	529.2	812.6	1216.	1827.	1743.	2569.	2467.	3197.
5050	392.8	534.4	820.7	1228.	1846.	1761.	1595.	2492.	3229.
5100	396.7	539.7	828.8	1242.	1864.	1778.	2621.	2517.	3261.
5150	400.6	545.0	836.9	1253.	1882.	1795.	2646.	2541.	3293.
5200	404.5	550.3	845.1	1265.	1901.	1813.	2672.	2566.	3325.
5250	408.3	555.6	853.2	1277.	1919.	1830.	2698.	2591.	3357.
5300	412.2	560.9	861.3	1289.	1937.	1848.	2723.	2615.	3389.
5350	416.1	566.2	869.4	1301.	1955.	1865.	2749.	2640.	3421.
5400	420.0	571.5	877.6	1314.	1974.	1883.	2775.	2665.	3453.
5450	423.9	576.8	885.7	1326.	1992.	1900.	2800.	2689.	3485.
5500	427.8	582.1	893.8	1338.	2010.	1918.	2826.	2714.	3517.
5550	431.7	587.4	901.9	1350.	2028.	1935.	2852.	2739.	3549.
5600	435.6	592.6	910.1	1362.	2047.	1952.	2877.	2763.	3518.
5650	439.5	597.9	918.2	1374.	2065.	1970.	2903.	2788.	3613.
5700	443.3	603.2	926.3	1387.	2083.	1987.	2929.	2813.	3645.
5750	447.2	608.5	934.4	1399.	2102.	2005.	2955.	2837.	3677.
5800	451.1	613.8	942.6	1411.	2120.	2022.	2980.	2862.	3709.
5850	455.0	619.1	950.7	1423.	2138.	2040.	3006.	2887.	3741.
5900	458.9	624.4	958.8	1435.	2156.	2057.	3022.	2911.	3773.
5950	462.8	629.7	966.9	1447.	2175.	2074.	3057.	2936.	3805.
6000	466.7	635.0	975.1	1460.	2193.	2092.	3083.	2961.	3837.
6050	470.6	640.3	983.2	1472.	2211.	2109.	3109.	2985.	3869.
6100	474.5	645.6	991.3	1484.	2229.	2127.	3134.	3010.	3901.
6150	478.3	650.9	999.4	1496.	2248.	2144.	3160.	3035.	3933.
6200	482.2	656.1	1008.	1508.	2266.	2162.	3186.	3059.	3965.
6250	486.1	661.4	1016.	1520.	2284.	2179.	3211.	3084.	3997.
6300	490.0	666.7	1024.	1533.	2303.	2196.	3237.	3109.	4029.
6350	493.9	672.0	1032.	1545.	2321.	2214.	3263.	3133.	4061.
6400	497.8	677.3	1040.	1557.	2339.	2231.	3289.	3158.	4093.
6450	501.7	682.6	1048.	1569.	2357.	2249.	3314.	3183.	4125.
6500	505.6	687.9	1056.	1581.	2376.	2266.	3340.	3207.	4157.
6550	509.5	693.2	1064.	1593.	2394.	2284.	3366.	3232.	4189.
6600	513.3	698.5	1073.	1606.	2412.	2301.	2291.	2357.	4221.
6650	517.2	703.8	1081.	1618.	2431.	2318.	3417.	3282.	4253.
6700	521.1	709.1	1089.	1630.	2449.	2336.	3443.	3306.	4285.
6750	525.0	714.4	1097.	1642.	2467.	2353.	3468.	3331.	4317.
6800	528.9	719.6	1105.	1654.	2485.	2371.	3494.	3356.	4349.
6850	532.8	724.9	1113.	1666.	2504.	2388.	3520.	3380.	4381.
6900	536.7	730.2	1121.	1678.	2522.	2406.	3545.	3405.	4412.
6950	540.6	735.5	1129.	1691.	2540.	2423.	3571.	3430.	4444.
7000	544.5	740.8	1138.	1703.	2558.	2440.	3597.	3454.	4476.
7050	548.3	746.1	1146.	1715.	2577.	2458.	3623.	3479.	4508.
7100	552.2	751.4	1154.	1727.	2595.	2475.	3648.	3504.	4540.
7150	556.1	756.7	1162.	1739.	2613.	2493.	3674.	3528.	4572.
7200	560.0	762.0	1170.	2632.	2510.	2510.	3700.	3553.	4606.

For example and notes see sheets 1 and 2, P 532.91

Smoothing THE WAY



KEEP THEM YOUNG WITH HYATTS

HYATTS ROLL MERRILY ALONG carrying heavy loads . . . eliminating bearing wear and care, keeping shafts, gears and wheels in perfect alignment . . . and making life easy, smooth, *and long*, for all mechanical equipment. Design them into the machines you build; look for them in the equipment you buy. Ask for further details. Hyatt Bearings Division, General Motors Sales Corporation, Harrison, New Jersey; Chicago, Pittsburgh, Detroit and San Francisco.

HYATT

ROLLER BEARINGS

QUIET

Topping Plant Revamped Into Up-to-Date Refinery

Cracked gasoline, clay-treated and doctor sweet, is manufactured in continuous flow from charge pumps to loading rack

By J. C. ALBRIGHT

ROTHSCHILD Oil Company, at Santa Fe Springs, California, is operating one of the newest and most up-to-date cracking plants on the Pacific Coast to manufacture cracked gasoline in a straight-line flow from the charge pumps to the loading racks without once stopping the commodity in various rundown tanks during the process. This company had operated a straight topping plant at Santa Fe Springs for several years, and had produced a gasoline not entirely satisfactory for present-day automobiles, but has turned to cracking to produce the high-octane fuel demanded by high-compression engines. The new cracking plant is a two-coil cracking system, employing two separate furnaces with a reaction chamber common to both heaters. The cracked gasoline flows without interruption through the stabilization unit from the main fractionating column, to a hot liquid-phase clay treater and a doctor-treating plant combined with a mercaptan removal system, to storage tanks or the loading rack as finished gasoline. A "midget" catalytic polymerization plant converts the olefins in the vapors from the stabilization plant to normal boiling fractions, which are condensed and blended directly with the cracked gasoline ahead of the doctor-treating plant.

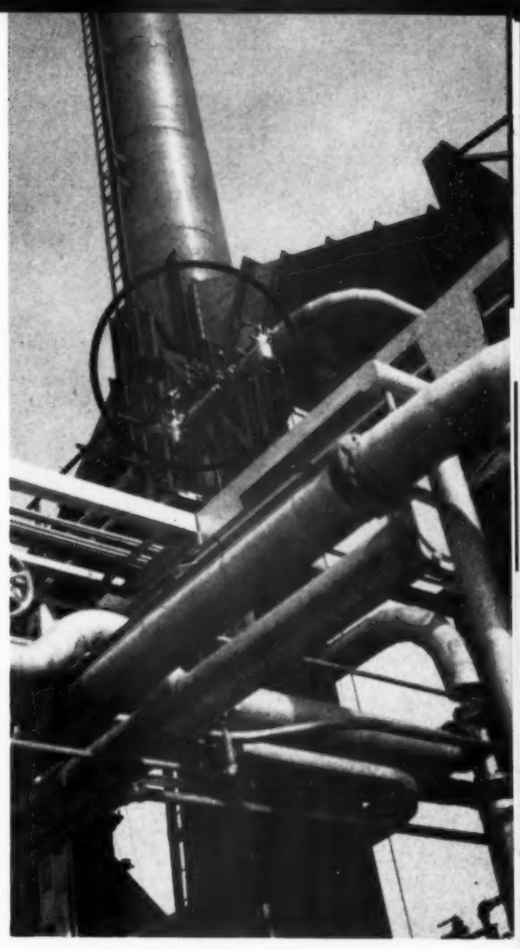
J. C. ALBRIGHT

was drilling superintendent for H. J. von Hagen in North Texas area, 1919-1921 — With the Noble Oil and Gas Company, Burkburnett, Texas, from 1921 to 1923—Joined staff of the Dixie Gasoline Company in 1923 and became Texas manager—Employed by Phillips Petroleum Company in 1925 and was sent to New Mexico where the company constructed a natural gasoline plant—Left Phillips in 1929 and for a time operated as a consulting engineer—In recent years has devoted virtually all his time to free-lance writing for trade journals.

Cracking Plant

A part of the raw charging stock in the cracking plant is produced at the skimming unit, consisting of all the gas oil that can be removed from the crude by normal topping procedure, but the reduced crude required in excess of that available from the company's own topping plant is obtained from other plants, not at this time equipped to crack the residuum. The heavy fuel—about 20° A.P.I. gravity — is pumped to the main fractionating column by a 7½ by 5¼ by 10 duplex steam pump at a pressure sufficient to deliver the charge to the main column at a daily rate of 2700 bbl. The fractionating column is more or less conventional — 5 ft. 6 in. by 55 ft.—containing 16 cast-iron bubble plates and 8 cast-iron side-to-side pans and is alloy-lined from the bottom to the eleventh plate to prevent corrosion.

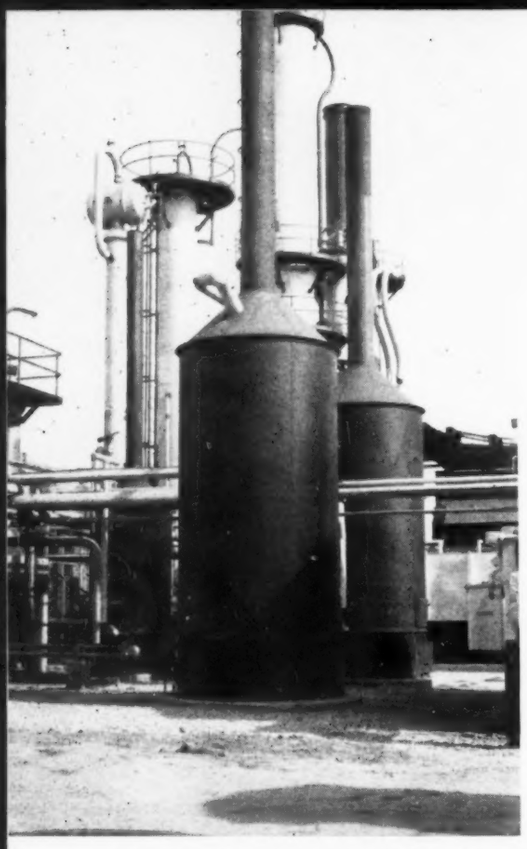
The charge is controlled by a liquid-level instrument operating in the lower section of the column, from which the heavy hot oil is withdrawn, plus heavy recycle, by a 5½ by 18 duplex, outside plunger-packed steam-engine-driven horizontal hot oil pump. This pump operates at a rate of 40 s.p.m. handling a commodity having a temperature of 700° to 725° F., and with a discharge pressure of 690 lb. gauge. The heavy-oil furnace receives the hot cracking stock through a flow controller that divides the charge into two equal streams; the furnace is equipped with 144 tubes



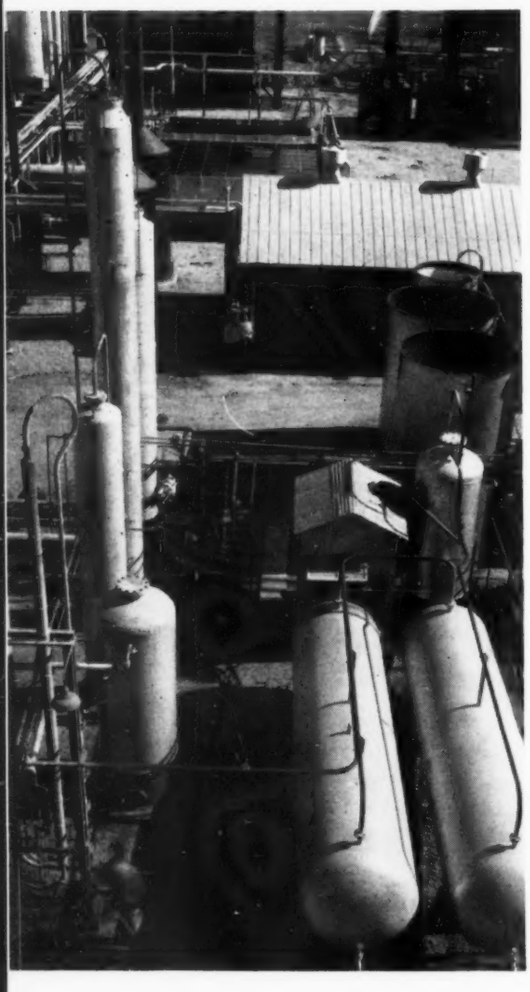
Furnace breeching into stack. Flow controller on split stream of heavy oil to furnace (in circle)

28 ft. long arranged for parallel flow with 72 tubes in each section of the heater. The tubes are 2¾-in. O.D. and 2¼-in. I.D. with 35 tubes in the radiant bank and 37 in the soaking and convection section. The flow through the heater is from convection to radiant tubes, with the split stream joining in a 4-in. line leading to the reaction chamber. The temperature of the heavy oil is from 720° F., inlet, to 916°F. in the heater outlet.

The light oil is picked-up from a side stripper connected to the main fractionating column so that the 28° gravity oil will flow outward directly into the stripper with the vapors released from the material passing back into the column at the eleventh plate. A liquid-level instrument on the side of the stripper prevents lowering of the liquid to a point that will break the seal on the down pipe from the eleventh to the twelfth plate. The hot light-oil pump operates on this instrument, taking the charge from the stripper as it is produced from the main column without lowering the liquid below the predetermined point. Part of this light oil flows through a separate line to the stabilizer reboiler from which it passes to coolers and the more or less conventional vapor



Vertical furnaces serving (1) polymerization columns, (2) clay-treating unit, and (3) rerun column



General view of treating plant in Rothschild refinery

absorber, returning to the cracking plant at control points.

The hot light-oil pump, having a bore of 4 in. and a stroke of 12 in., discharges the light oil at a rate of 3000 bbl. per day—including recycle—to the light oil furnace with a discharge pressure of 550 lb. gauge. The temperature of the light oil is approximately 570° F. at the suction of the charge pump, as it enters the 152, 16-ft. tubes arranged in a continuous series. These tubes have an O.D. of 2¾ in. and an I.D. of 2¼ in. The oil enters the topmost row of the convection section, which contains 72 tubes, then flows through 35 tubes on the inner wall of one side of the furnace, passing upward and crossing over through 10 tubes to flow downward on the opposite side of the furnace through an additional 35 tubes to the furnace outlet, or transfer line.

Both commodities—the heavy and light oil—join at the reaction chamber in a 4-in. nozzle inside the chamber containing a wall-washing connection. The column is 4 ft. 6 in. by 40 ft., has $1\frac{1}{16}$-in. walls alloy-lined throughout, and covered on the exterior with 4 in. of insulation. The outlet slide valve is automatic in operation, being controlled by an instrument on the control panel in the pump room so that the operation may be changed by the operator, at will, without leaving the instruments.

The flash tower is 6 ft. 6 in. by 30 ft. with ⅝-in. walls completely alloy-lined and has two outlets at the top, one serving the 6-in. relief valve, the other being connected to the 6-in. vapor line. Residuum averaging 8.5° gravity is withdrawn from the base and vapors leave the top to be fractionated in the main column as cracked gasoline, light oil charge and recycle, and heavy oil recycle. The cracked vapors are liquefied in submerged coils containing 6400 sq. ft. of condensing surface, which lowers the temperature of the vapor stream from 375° F. at the outlet of the fractionator to 90° F. at the liquid receiver. Condensate is pumped back to the top of the main column with a ratio of 2:1 reflux to overhead product, so that the cracked gasoline will be produced with an end point of about 400° F.

The vapors from the distillate receiver flow to a conventional absorption column 2 ft. 6 in. by 22 ft. 6 in. having 16 bubble plates with light oil from the stabilizer preheater flowing from the top of the absorber to the base and back to the plant for temperature control. The distillate is pumped with a 7½ by 4 by 10 duplex steam pump through a 1½-in. line to the 26-tray pressure-distillate stabilizer, operated at 182 lb. gauge pressure and having a reboiler temperature of 360° F. Overhead condensate is pumped back to the column at a ratio of 1:1 reflux to column feed, to maintain a top temperature of 165° F. so that the bottom product will have a Reid vapor pressure of 6.8 lb. The distillate flows from the stabilizer through two exchangers, one in transfer with charge to product, and the other with water pumped through it to cool the distillate for further handling.

The vapors from the stabilizer contain an olefin percentage of about 36, and the combined feed to the compressor has a content of about 22 percent. These vapors are compressed to 488 lb. gauge and heated in a vertical furnace equipped with a helical heating coil and conditioned with the required quantity of moisture to flow in series through the two catalytic columns. Conversion in these two columns of the olefins is about 94 percent based on standard operation during November, 1940, when the combined vapor feed contained 56 percent fresh gases and 44 percent recycle stock.

Clay Treating and Rerun Unit

Cracked gasoline manufactured in the cracking plant contains gums that are removed by treating in the hot liquid phase with clay and subsequent rerunning and fractionating to the required end point. The equipment necessary for this treatment consists of, first, a vertical heating unit with 456 lineal ft. of 3-in. tubing in the form of a helix over a single gas burner in the base of the furnace; second, a clay tower filled with California decoloring clay, and, third, a fractionating column served by another vertical heater with a helix containing 456 lineal ft. of 3-in. pipe, which is used as a direct-fired reboiler instead of the more conventional steam-heated reboiler, or one deriving its heat from a side stream taken from the cracking plant.

In continuous flow from the cracked stabilizer, the commodity is pumped with an 8 by 4 by 12 duplex steam pump working against a discharge pressure of 267 lb. gauge to the helical heater by which the temperature is maintained at 462° F. at the 2-in. transfer line, which leads directly to the top of the hot-phase clay-treating column. The column has a diameter of 7 ft. and a height of 30 ft. with a 16-

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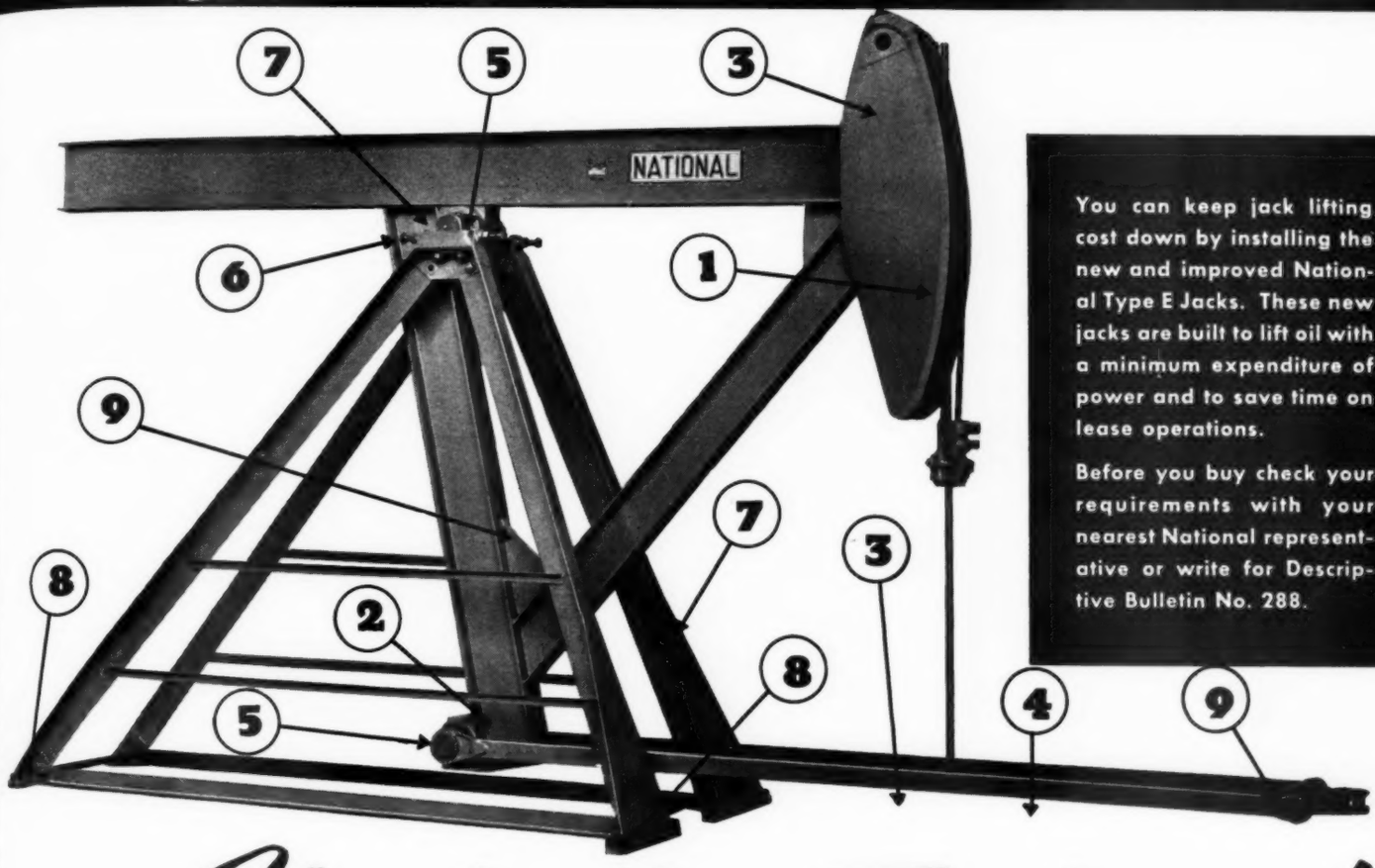

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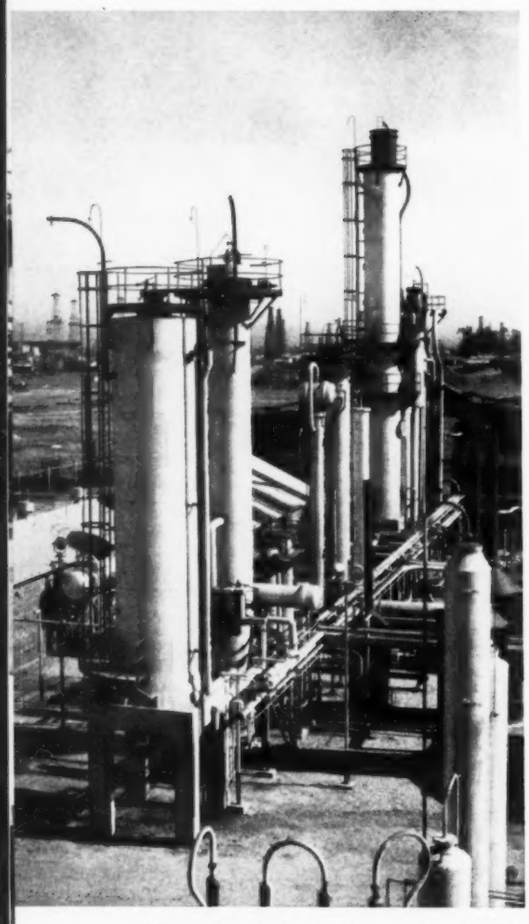


View of principal columns showing hot liquid-phase clay tower in left foreground

in. bottle-neck combination liquid outlet and flanged manhole at the lower head. In the neck of this outlet is placed a slotted screen supporting a thin layer of pea-gravel upon which is placed about 28 ft. of Muroc clay as a solid bed.

The inlet nozzle through which the heat distillate flows is fitted, on the inside of the column, with a distribution header to spray the commodity evenly over the top of the clay bed. The hot material percolates downward through the bed of clay and flows through a 4-in. line to the rerun column. This column is 4 ft. in diameter and 43 ft. high, containing 14 cast-iron bubble plates and one liquid accumulator pan near the base. The clay-treated material enters the rerun column on the twelfth plate through a pressure control instrument that reduces the clay tower pressure of 252 lb. to the fractionating column pressure of 5 lb.

The liquid that falls downward over plates No. 12, 13, and 14, is caught in the drawoff pan in the base from which it is picked-up by an 8 by 6 by 10 duplex steam pump that delivers the liquid at a pressure of 12 lb. gauge through the direct-fired reboiler. A temperature of 487° F. is maintained on the transfer line from this heater with the commodity returning to the fractionating column to enter the lower section just below the liquid drawoff pan. It is sprayed over a distribution plate immediately below the ell on the internal line so that it will be agitated violently to release desired fractions, which are immediately vaporized. The desired gasoline fractions pass upward through the column and are fractionated to an end point of 390° F. with rerun distillate pumped back over the column at a ratio of 1½:1, reflux to recovered distillate.

The overhead vapors from the fractionator, at a temperature of 281° F., are cooled and liquefied in a shell-and-tube condenser, from which the liquid distillate flows to a 3-ft. by 8-ft. rerun distillate receiver. The 7½ by 5 by 10 duplex steam pump that delivers the reflux to the top of the fractionator also is used to pump the finished gasoline to the treating plant where it is finished as sweet, non-corrosive gasoline and inhibited to prevent formation of gums.

The material in the base of the fractionating column is removed with a 4½ by 2¾ by 4 duplex steam pump at a rate controlled by the rate of formation of the bottoms, which averages about 2 to 2¼ bbl. per hour. This heavy liquid, containing the polymers separated from the gasoline by the action of the clay in the treating column and by distillation in the rerun unit, has a gravity of about 28.5°. The flash point of the polymers is about 166, and the initial boiling point about 404° F. It is disposed of by either pumping it back to the cracking plant flash chamber for rerunning through the cracking plant, or pumping to the residuum storage to be blended with the heavy industrial fuel removed from the cracking plant flash chamber after cooling.

When operating a combination hot liquid-phase clay treating and gasoline rerunning plant, several problems have been solved, among which is color control. It was discovered that, if the temperature of the clay contact bed—by holding the temperature of the heating furnace too high—was equal to the rerun reboiler temperature, the distillate resulting from rerun operations would have an unsatisfactory color. Temperatures must be controlled, therefore, to suit the characteristics of the cracked gasoline derived from a specific charging stock. If the heater temperature—in the transfer line from the helical coil on the clay tower—is held at about 35 to 40° F. lower than the heater outlet temperature on the fractionating column base inlet, colors of about plus 23 to 24 can be obtained. The rate of flow through the clay tower helical heating coil is approximately 35 gal. per min., with a rerun production of about 33½ gal. per min., after polymers have been separated from the product in the rerun fractionating column.

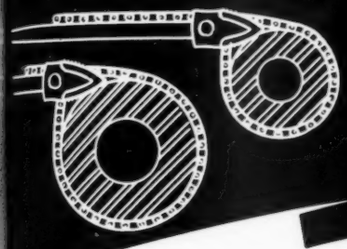
H_2S and Mercaptan Removal System With Doctor Sweetening

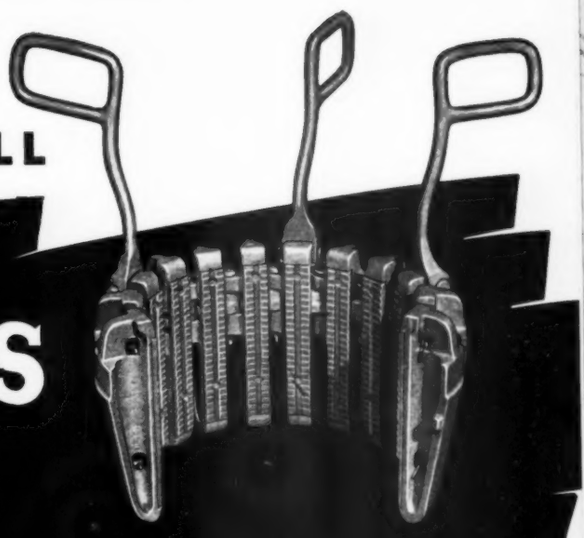
The cracked gasoline is washed with a solution of caustic in two stages to remove hydrogen sulphide, in the first step, and to reduce the percentage of mercaptans in the second, prior to treating the commodity with doctor solution. This series of processes follows immediately upon rerunning the gasoline to remove polymers formed in the clay tower, and for control of end point and color. The 7½ by 5 by 10 duplex steam pump that is used to pump the condensate back over the rerun tower (in the proportion of 3000 gal. of reflux to 2100 gal. of production so that the end point will be about 396°F.) also delivers the commodity to the caustic contact columns and through the doctor-treating plant to storage.

In the first contact between the gasoline and the treating solutions, there is placed a vertical vessel 2 ft. 6 in. in diameter and 15 ft. high into which is pumped about 8 bbl. of 14° Bé. caustic. This solution remains in the hydrogen sulphide scrubber without recirculating or pumping, and the gasoline being treated is broken up so that it will rise through the liquid to the top of the tower. The 2-in. transfer line is attached to an 8-in. flange near the base of the tower, and an extension is attached to the inner side of the flange, which is perforated with ¼-in. holes to afford 150 percent area of the transfer line. About 4 ft. of free space is left in the tower above the caustic solution so that the heavier liquid will separate from the gasoline as it rises to the top and flows to the base of the second contact tower. The caustic solution remains in the hydrogen sulphide scrubber until it is approximately 75 percent spent, which is usually after about 2000 bbl. of gasoline has been treated, when it is dumped to disposal tanks and subsequently handled by the Santa Fe Springs Coöperative Waste Water Disposal Association.

The second caustic contacting tower is 28 ft. high and 2 ft. 6 in. in di-

HANDLE STREAMLINED DRILL COLLARS SAFELY WITH BAASH-ROSS





...Slips. ...and "C-S Regu-...types have renewable liners—...valuable economy feature—and the same liners fit slips of both types. (See above.)

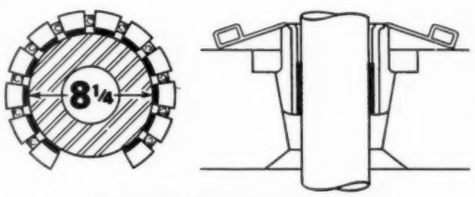
Many long and costly fishing jobs have been caused by the failure of incorrectly fitting rotary slips to hold the streamlined drill collars. Conventional slips, having liners machined to fit on a given fixed diameter, may contact the drill collar properly for only a few runs. As the drill collar becomes worn through abrasion by the formation, the slips cannot adapt their gripping surfaces to the smaller diameter, and the danger of dropping the drill collar increases rapidly.

These new Baash-Ross Drill Collar Slips are especially designed for gripping the streamlined drill collar securely and safely, even though it has been worn as much as 1½ inches *smaller than its original* O.D.!

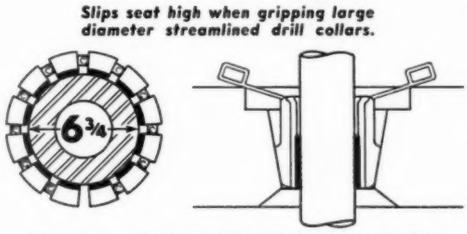
"C-S Long" Type Drill Collar Slips, illustrated, are used in combination with the Baash-Ross Safety Clamp, which is attached above the Slips before the joint is broken, and provides a stop shoulder for maximum safety in handling streamlined drill collars.

Multi-Segment Construction Compensates for Wear of the O.D. of Drill Collars

Made up of several narrow segments flexibly hinged together into one unit, Baash-Ross Drill Collar Slips are automatically adjusted to grip on varying diameters as they are seated in the master bushings. When seated at the top of the tapered bore they are in position to grip the maximum diameter within their range. As the drill collar becomes smaller in diameter, the slips seat lower in the taper, drawing together and accommodating themselves to the size of the drill collar. The liners are vertically and radially aligned to take a full-length, positive grip, and the range between maximum and minimum O.D. that can be handled safely is 1½ inches on the O.D. of the drill collar.



Slips seat high when gripping large diameter streamlined drill collars.



Slips are automatically adjusted to smaller diameters by seating lower in the master bushings.

Eliminate the risk of dropping your drill collars—for safety's sake, use BAASH-ROSS DRILL COLLAR SLIPS.

SEND FOR NEW BULLETIN or refer to the BAASH-ROSS SECTION OF YOUR NEW 1941 COMPOSITE CATALOG

New Drill Collar —Good Grip

Worn Drill Collar —Poor Grip

Why Ordinary Rotary Slips May Fail To Hold Streamlined Drill Collars

The liners of conventional rotary slips are machined to fit and grip objects of a given fixed diameter. They will hold the streamlined drill collar when it is new.

BUT . . . as the diameter of the drill collar is reduced through wear, the area of gripping contact of fixed diameter liners diminishes, as at left, and the danger of the drill collar dropping through slips increases.

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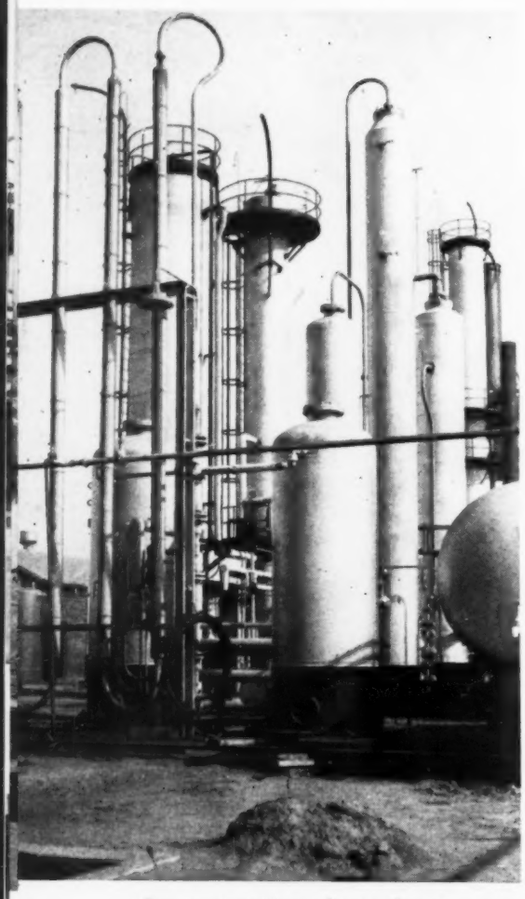

Doctor-treating plant, showing contact columns on left and sand filter on right

ameter, being equipped with a subway grating support 4 ft. from the base upon which are placed 21 ft. of 1½-in. carbon Raschig rings to accelerate contact between the gasoline and the caustic solution, which is recirculated and regenerated continuously. The gasoline at a temperature of about 90°F. enters the base of the mercaptan scrubber through a perforated line similar to that employed in the hydrogen sulphide scrubber, and rises, countercurrent, through the descending caustic and leaves the tower at the top through a 2-in. line leading to the doctor-treating system.

The caustic employed in the mercaptan scrubbing unit is made-up to 20° Bé. and flows from the base of the mercaptan scrubber through a liquid-level-controlled valve in the 2-in. outlet line. The level of the caustic in the mercaptan scrubber is controlled in the lower end of the tower with an exterior "kidney valve" that remotely controls the outlet valve. When the mercaptan scrubber was installed, this level controller was placed at the top section so that the tower would remain approximately filled with solution, but subsequent operation required that it be removed and placed on the lower section of the tower to prevent possible priming that might be the result of a tight emulsion. The present installation permits contact between the gasoline and the caustic, but also permits an easier break so that the gasoline will flow from the tower with a minimum amount of entrained caustic solution.

In the flow of the caustic solution from the mercaptan scrubber to the caustic regenerator, the chemical passes through a 2-in. line to a series of caustic heat exchangers covered with 2 in. of insulation where heat is transferred from the regenerated caustic to the caustic entering the regenerator. A second exchanger superimposed above the flow exchanger is employed to heat the chemical with steam to a temperature of about 240°F. At this temperature, the caustic enters the regenerator tower (in this plant called the caustic stripper) in which the mercaptans are removed from the solution. The tower has a diameter of 2 ft., 6 in., and a height of 20 ft. At a distance of 5 ft. from the base, a support of subway grating is installed upon which is placed 14 ft. of 1½-in. carbon Raschig rings that almost fill the tower to the 16-in. flanged opening at the top.

The heated caustic enters the caustic stripper 3 ft. from the top through a 2-in. line attached to a 3-in. flanged opening, with the 2-in. line extended into the tower and drilled with ¼-in. holes for adequate distribution of the caustic over the upper section of Raschig rings. The caustic flows downward through the bed of rings to meet a flow of exhaust steam rising from a perforated 4-in. line in the tower just above the subway grating with the perforations looking upward. The quantity of steam admitted to the caustic scrubber is controlled to that amount required to maintain a water content that will hold the solution at a constant gravity of 20° Bé. when the tower is operated between 5 and 7 lb. gauge pressure with the solution entering the tower at a temperature of 240°F.

The regenerated caustic flows from the base of the tower, passes through the heat exchangers and then enters a second exchanger in which the solution is cooled to about 98°F., and is then picked-up by a 6 by 4 by 6 recirculating pump and delivered again to the mercaptan scrubber. The mercaptans, driven from the caustic solution by heating and agitating with steam in the tower, pass off through a 4-in. line to a mercaptan separator to accumulate any caustic solution leaving the regenerator, and the mercaptan vapors flow through a 2-in. line to the cracking plant to be burned in the breeching of the cracking furnace stack.

The gasoline, freed from hydrogen sulphide and having a reduction of about 75 percent of the mercaptan sulphur, flows from the top of the mercaptan scrubber tower to the doctor-treating plant through a 2-in. line connected to the first contactor where doctor solution and gasoline meet. The contactor is a 3-ft. length of 3-in. pipe, having an iron mixing nozzle in either end, the top being flanged and connected to a second set of mixing nozzles in a second nipple. The doctor solution is recirculated through the sets of nozzles, with sulphur-laden gasoline admitted in quantities sufficient to obtain the desired "break," through a "harp" containing a 1-in., a ½-in., and a ¼-in. line with gates to control the flow of sulphur by manual setting. Following the iron mixing heads are four vertical columns, made of 5-in. pipe, 20 ft. long and containing 8 orifice baffles, with each baffle containing four ¾-in. holes, each baffle spaced 2 ft. 6 in. from the other. The flow of doctor solution and gasoline being treated is in series through these contact columns, with the outlet of the last column connected to a 2-in. pipe leading to two settling drums.

The settling drums are connected in series, and have the separated doctor solution outlet connection end 1 ft. lower than the other end of the vessel. The doctor and gasoline enter the first drum through a 2-in. line, which is continued into the drum near the lower side, having ¼-in. perforations, the combined area of which is equal to 200 percent of the inlet area. Gasoline rises to the top of the drum and passes to the next where connections and conditions are similar to the first. The doctor-sweetened gasoline flows from the upper side of the last drum through a 2-in. line to a sand filter, which is 4 ft. in diameter and 8 ft. high, containing a sand bed 5 ft. in depth. The sand being used currently in this drum is extremely fine, ocean beach sand, but permitting passage readily for the gasoline flowing from top to base. Gasoline flows to storage and separated moisture flows from the base of the filter to plant disposal lines.

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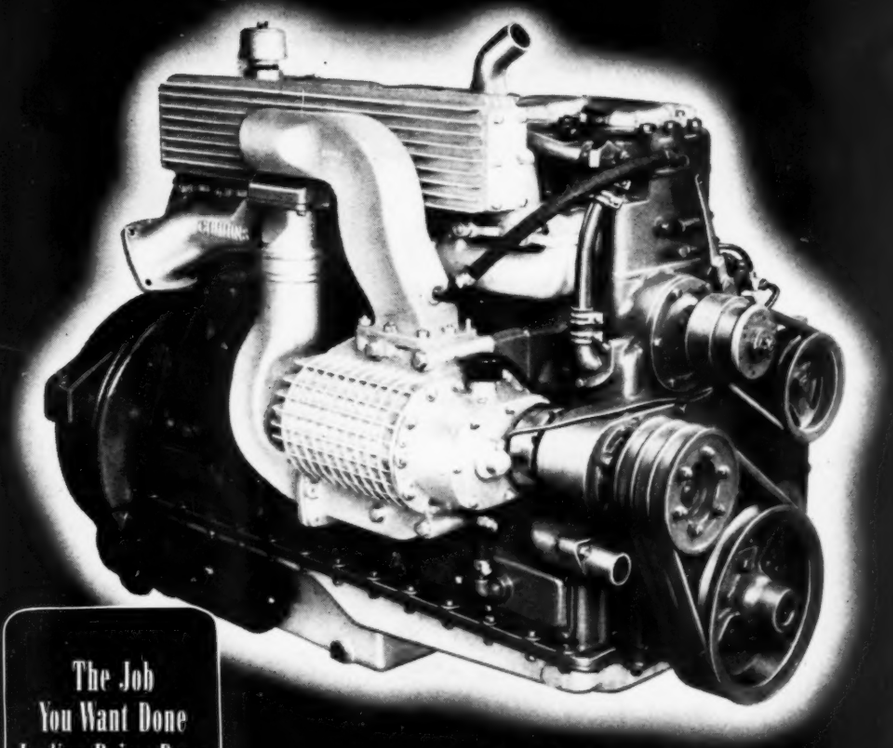

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Running Tour
WITH MEN IN THE INDUSTRY

R. W. WILSON, manager of the Baroid Well Logging Service, recently gave an interesting talk before the Texas A. and M. Petroleum Engineering Club, speaking on the subject: "The Baroid Method of Well Logging." The talk was illustrated with slides. Accompanying Wilson to College Station was R. C. MARR, also of the Baroid Well Logging Service.

FRED M. MANNING, of Manning and Martin, Denver, Colorado, drilling contractors, recently made a trip to the Mid-Continent area.

HENRY WATERS, Tulsa, Oklahoma, has been named assistant general manager of the Standard Oil Company of Indiana's crude oil purchasing department, and FRED E. WOOD, Chicago, Illinois, has been made assistant to A. W. PEAKE, vice-president in charge of production for Standard of Indiana. These promotions were effective January 1.

WM. RAY HALL, formerly with Carter Oil Company, has become associated with Jarvis Bros. and Marcell of Decatur, Illinois. Hall is superintendent of the Albion district, Illinois, being in charge of drilling and production operations.

NORVAL F. MYERS, Los Angeles, California, manager of refineries, Union Oil Company, has resigned to join the staff of Socony-Vacuum Oil Company. He is now making his headquarters in New York City.

WARREN WYNN, geologist, Sinclair Prairie Oil Company, has been transferred from the Tulsa, Oklahoma, office of the company to Bismarck, North Dakota.

J. S. HAWLEY, assistant purchasing agent for the Stanolind companies, recently was chosen president of the Purchasing Agents Association of Tulsa to succeed H. E. KAISER of the Phillips Petroleum Company. Other officers elected were: C. G. MCCLAREN, Shell Oil Company, Inc., first vice-president; J. H. WOLFE, British American Oil Producing Company, second vice-president, and R. R. BURRIS, Sun Oil Company, secretary.

R. S. WARNOCK, Magnolia, Arkansas, has been appointed to the Arkansas Oil and Gas Commission to succeed L. A. LONGINO, resigned.

H. D. MURRAY, engineer with The Texas Company, who has been stationed at Jal, New Mexico, is now making his headquarters at Sundown, Texas.

T. W. HAUGHT, superintendent, Ohio Oil Company, has been transferred from Eliasville, Texas, to Bay City, Texas.

W. K. HALEY, superintendent for Barnsdall Oil Company, formerly at Mankins, Texas, is now at Odessa, Texas.

H. J. SUMMY, superintendent for Sinclair Prairie Oil Company, has been transferred from Midland, Texas, to Arp, Texas.

L. A. MYLIUS, Centralia, Illinois, consulting geologist, has opened a branch office in Evansville, Indiana.

LLOYD DANIELS, drilling superintendent for W. G. Ray Drilling Company, is now making his headquarters in Minden, Louisiana. He has been at Jackson, Mississippi.

T. E. DE CILLIERS, resident chemist at Ponca City, Oklahoma, for Cities Service Oil Company, has been made assistant chemist and moved to the company's research laboratory at Okmulgee, Oklahoma.

ROBERT M. BASS, who has been superintendent in the East Texas field for Sinclair Prairie Oil Company, resigned recently to operate as a drilling contractor. His headquarters are at Kilgore, Texas.

H. E. DRALLE, manager of the Petroleum and Chemical Section of Westinghouse Electric and Manufacturing Company, recently made a business trip to Dallas, Houston, New Orleans, and was also in attendance at the Petroleum Electric Power Association meeting at Baton Rouge, Louisiana, December 13, where he delivered a talk, "Expanding Horizons," illustrated by moving pictures.

GOVERNOR ROY E. AYERS of Montana has named CHARLES N. WRIGHTER, Kelvin, and LEE J. YEALEY, Shelby, both independent operators, to the Oil Conservation Board of Montana.

A. P. LOSKAMP is district manager of the office recently opened at Midland, Texas, by the Union Oil Company of California. He formerly was in charge of the West Texas district office at Midland for the Barnsdall Oil Company. J. D. MCCLURE has been transferred to Midland from Michigan by Barnsdall to assume Loskamp's vacated post.

DR. NELSON H. DARTON of Washington, D. C., has been awarded the Penrose Medal by the Geological Society of America. The presentation was made at the society's annual meeting in Austin, Texas.

B. A. RAY, geologist, Tide Water Associated Oil Company, Midland, Texas, recently was elected president of the Midland Geological Society. F. L. BATES of The Texas Company was chosen vice-president, and W. LLOYD HASELTINE, Magnolia Petroleum Company, secretary-treasurer.

HARRY A. WALLACE, JR., Charleston, West Virginia, who was formerly assistant general manager of the Charleston group of Columbia Gas and Electric Corporation Companies, has been elected vice-president of those companies operating in southern Ohio, West Virginia, and Kentucky. The post was created at the December meeting of the Columbia Gas and Electric Corporation directors in New York.

J. S. NEILSON, independent operator, has moved his headquarters from Houston, Texas, to Lake Charles, Louisiana.

IRA BRINKERHOFF, geologist at Houston, Texas, for the Stanolind Oil and Gas Company, has been transferred to Chicago, Illinois. RAY C. LEWIS, who has been at San Antonio, Texas, will succeed Brinkerhoff as Gulf Coast district geologist and will make his headquarters in Houston.

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REPUBLIC STEEL DEFENSE FOR AMERICA

REPUBLIC STEEL CORPORATION

PHILLIP M. ROBINSON, chief engineer for The Pennzoil Company, Oil City, Pennsylvania, has been appointed assistant to DR. R. E. WILSON, head of the petroleum section, raw materials division of the advisory commission to the Council of National Defense. Granted a leave of absence by The Pennzoil Company, Robinson assumed his new post December 16. His work in Washington will be in connection with the refining department of the industry. It will include surveys of the ability of the petroleum industry to manufacture suitable fuels and lubricants for army and navy operation. He will also serve as consultant to the army and navy on specifications for fuels and lubricants.

L. L. SMITH, assistant treasurer of B. F. Goodrich Company, Akron, Ohio, has been elected to the position of treasurer, it is announced by D. M. GOODRICH, chairman of the board. COLONEL A. A. SPRAGUE, of Chicago, Illinois, chairman of the board of Sprague-Warner Company, and formerly a director of The B. F. Goodrich Company from 1930 to 1938, was re-elected to the board, it was announced.

For the last six months GEORGE W. VAUGHT has served as treasurer of the Goodrich company, as well as vice-president, in which capacity he is continuing.

LARRY SEAMAN, who has been head of the Fort Worth, Texas, geophysical department for Sinclair Prairie Oil Company, has been transferred to Tulsa, Oklahoma, as head of the Mid-Continent geophysical department.

JOHN E. VANDALL, of the Magnolia Petroleum Company, has been elected president of the Oklahoma City Geological Society. CLYDE E. DORR, consulting geologist, has been chosen vice-president, and GRAYDON H. LAUGHBAUM, Sinclair Prairie Oil Company, secretary and treasurer.

WILLIAM A. EBERLE, general superintendent of the Eagle Works of the Standard Oil Company of New Jersey, has retired after 38 years' service with the company. A dinner was given in his honor, presided over by FRANK W. ABRAMS, a director of the company.

DR. E. R. LEDERER recently resigned as president and general manager of the Bradford Oil Refining Company, a position he has held since 1936. At one time L derer was vice-president in charge of refinery operations for the Texas Pacific Coal and Oil Company. He plans to continue residing at Bradford for the present.

C. B. WILLIAMS, who has been manager at Cucuta, Colombia, for the Colombian Petroleum Company, has returned to the United States and his post in Colombia has been assumed by C. O. ISAKSON.

PAUL C. DEAN, independent operator, has been chosen president of the Fort Worth Geological Society. C. L. MOHR, of the Ambassador Oil Company, was elected vice-president, and W. J. HILSEWECK, of Gulf Oil Corporation, secretary-treasurer.

BERT L. LIGON, independent operator of Wichita Falls, Texas, passed away January 6 after a brief illness. Ligon was well known in the oil industry. He had seen service with several supply companies and immediately before becoming an independent operator was a partner in the Wilson Manufacturing Company, Wichita Falls.

R. L. BATES, geologist for The Texas Company at Midland, Texas, has resigned to become associated with the New Mexico Bureau of Mines and the New Mexico School of Mines, Socorro, New Mexico.

JOHN A. GILLAN has succeeded HENRY SALVATORI as president of the National Geophysical Company, Dallas, Texas, the latter having retired January 1.

C. S. ATWELL, vice-president of Sogac Pipe Line Company, making his headquarters at Barranquilla, Colombia, has been transferred to the refinery department of The Texas Company in the United States. After a vacation he likely will have his headquarters at the company's refinery at Port Arthur, Texas.

B. D. OSBORNE, mechanical engineer, Shell Oil Company, Inc., is now making his headquarters at McPherson, Kansas, having been transferred from Lucien, Oklahoma.

W. M. VANDIVERT has been made North Central Texas district manager by Bethlehem Supply Company and will make his headquarters at 824 Hamilton Building, Wichita Falls, Texas.

S. L. GILLIAM, assistant purchasing agent for the Mid-Continent Petroleum Corporation, Tulsa, Oklahoma, has been named purchasing agent to succeed C. A. PRICHARD, who resigned recently to associate himself with the Anderson Prichard Oil Corporation, Oklahoma City, Oklahoma. C. W. WALLACE has been made assistant purchasing agent.

R. A. STACY, Shreveport, Louisiana, vice-president of the Delta Drilling Company, resigned January 1 to go into business for himself.

B. J. CURRY has been made petroleum engineer for the Lone Star Gas Company in the Opelika field, Henderson County, Texas. Curry graduated from Texas A. and M. College in June, 1940.

R. L. WALES, engineer with The Texas Company, has been transferred from Waynesboro, Pennsylvania, to Auburn, Indiana.

MAX LYON, engineer, Carter Oil Company, is now stationed at Beloit, Kansas, having been transferred from Mandan, North Dakota.

STANLEY S. LEARNED, chief engineer for the Phillip's Petroleum Company, has been made assistant manager of the company's newly organized gasoline pipe line department. A. W. HUBBELL is manager of the department. E. F. KINDSVATER becomes chief engineer of Phillips, M. M. HOLMGREN test engineer, and C. W. HUBBELL assistant chief engineer.

D. H. DUKE, Centralia, Illinois, exploitation engineer for Shell Oil Company, Inc., has been called to active duty as a first lieutenant in the Sixty-third Coast Artillery. He is now stationed at Galveston, Texas.

HARRY L. ERLICHER, purchasing agent of General Electric Company since 1931 and an employee of the company for 40 years, has been elected a vice-president. He will continue to be in charge of the company's purchasing activities.

E. E. HAUBETTER recently was made assistant district sales manager in the Houston, Texas, territory for Republic Steel Corporation. He has been on the staff of Republic Supply Company the last five years and before that was with Carter Oil Company.

C. R. SWANK, Shreveport, Louisiana, has been retired by Magnolia Pipe Line Company as superintendent of the Louisiana-Arkansas district. He has been engaged in the pipe-line industry for 44 years, having been with the Eureka Pipe Line Company and the Buckeye Pipe Line Company prior to moving to Texas and helping to construct the Magnolia system.

J. A. MCCARTY, petroleum engineer, Gulf Oil Corporation, has been transferred from Webb City to Fairview, Oklahoma.

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LAUGH WITH BARNEY

Two workers settled down to eat their dinner. One began unwrapping a large parcel at which the other stared in surprise.

"What's that?" he asked.

"Well, it's like this. My missus is away so I thought as I'd make myself a pie."

"Bit long, ain't it?"

"Oh, I dunno, it's rhubarb."

* * *

"How did you get that bump?"

"My wife threw a vase at me."

"Why on earth didn't you duck?"

"I did, but she allowed for it."

* * *

Boss: Now, look here! Why hasn't this job been done? It's more than a month since I told you to do it.

Clerk: I forgot it, sir.

Boss: Forgot it! Suppose I forgot to pay your salary. What would you say then?

Clerk: I would tell you at once, sir—not wait a month and kick up a fuss about it!

* * *

"Shine, please, boy!" said the six-foot-five soldier to the shoeblack.

The boy looked down at the vast expanse of boot before him and shook his head questioningly. Then a determined look covered his face.

"Bert," he called out to another boy, "Gimme a hand! I've got an army contract!"

* * *

Housewife: Are you really content to spend your life walking about the country, begging?

Hobo: No, lady, not at all. Many's the time I wished I had a car.

* * *

Teacher: Now, children, a collision is two things coming together unexpectedly. Andy, give me an example.

Andy (shyly): Twins?

* * *

A dog was running down the street.

"Hey," yelled a fire hydrant, "come on over and have one on me."

"Nope," replied the dog, "I'm going down in the next block and have one on the house."

* * *

The young man who had been called up explained volubly that in his case there was no need for a medical examination.

"I'm fit and I want to fight. I want to go over on the next boat. I want to go right into the front line, but I want to have a hospital close, so that if I get hit no time will be wasted in taking me where I can get mended right away, so that I can get right back to the line without losing a minute. Pass me in, doctor. Don't waste any time on me. I want to fight, and keep fighting!"

The doctor, however, insisted, and when he had completed his examination he reported a perfect physical specimen.

"You don't find anything wrong with me?" asked the man.

"Nothing."

"But, doctor, don't you think I'm a bit crazy?"

* * *

The tramp entered the doctor's office. There was a worried look on his face.

"Doctor," he said, "you've got to help me. I swallowed a quarter 25 years ago."

"Good heavens, man!" ejaculated the doctor. "Why have you waited all those years? Why didn't you go to a doctor the day you swallowed it?"

"To tell the truth," replied the tramp, "I didn't need the money at the time!"

* * *

"Do you know what the ram said after he fell over the cliff?"

"No, what?"

"I didn't see that ewe turn."

* * *

She: Do you think I show distinction in my clothes?

He: Well, I wouldn't say distinction. I think distinctly would be a better word.

* * *

Middle age is that period in a man's life when he'd rather not have a good time than have to get over it.

* * *

The reason no woman has ever married the man in the moon is because he only makes a quarter a week, gets full once a month, and stays out all night.

* * *

Many a man has made a monkey out of himself by reaching for the wrong limb.

* * *

A medical journal advances the theory that "man is slightly taller in the morning than he is in the evening." We have never tested this, but we have certainly noticed a tendency to become "short" toward the end of the month.

It was 2:00 A. M. when the club telephone rang, and a bachelor member answered it.

"Is my husband there?" demanded an angry feminine voice.

"No, he's gone home," was the reply.

"How do you know?" snapped the voice. "I didn't even tell you his name."

"You didn't need to," was the retort. "When this phone rang every darned married man in the place grabbed his hat and ducked out."

* * *

One thing men will never understand about women is how they manage to get into the garage on the last drop of gasoline.

* * *

Very late one night two chaps who had been imbibing too freely were sitting on the pavement with their feet in the gutter. One was heard to say to the other, "What does your wife shay when you shtay out late like thish?"

"Haven't got a wife," the other replied.

"Then why do you shtay out late like thish?"

* * *

She: Do you know what happens when a body is immersed in water?

He: The telephone rings.

* * *

A party of Scots decided to make a trip to London, and when they assembled at the station it was found that they numbered 13.

Not wishing to tempt Providence they decided to toss a coin to see who would stay behind.

Unfortunately, the coin fell beneath the platform and they all missed the train.

* * *

A hypochondriac consulted a doctor for a thorough checkup. After going over the patient carefully, the doctor inquired of him as follows:

"Do you drink?" Reply was "No, doctor."

"Do you run around nights?" Reply was "No, doctor."

"Do you swear excitedly?" Reply was "No, doctor."

Thereupon the doctor inquired if he felt pain on each side of the head.

"Yes, doctor, I do," was the patient's reply.

"Well, my man, your only trouble is your halo is too tight," concluded the doctor.

They Say...

THE REWARD OF ACHIEVEMENT IS RECOGNITION

. . . and if this is true we have been bountifully rewarded through the recognition of the BAKER MODEL "K" CEMENT RETAINER by the Oil Industry.

Like most rewards, Recognition must be earned, and this original device is the result of 30 years of research and development by Baker engineers. So original is the Baker CEMENT RETAINER that even its name was "coined" to express its function of placing cement and fluids in oil wells under high pressures, at the time desired and at the proper point to accomplish the desired results. Old timers will remember that this operation was considered practically impossible prior to the introduction of the Baker Cement Retainer, but today—after constant improvement and first-hand knowledge and field experience gained through thousands of runs—the remarkable results obtained by using the 1941 version of the Baker Cement Retainer are accepted as a matter of course.

These are the most important facts to be remembered concerning the Baker Model "K" Cement Retainer: The correctness of its design and construction has been field tested in thousands of wells ● It is dependable ● Its construction is simple ● It is easy to operate ● It will withstand extremely high pressures (greater pressures than can be imposed safely upon the casing in which it is recommended to be set) ● It can be used for more than a dozen important field operations involving cementing, well repair and well completion work.

If you do not have full knowledge of the design and operation of this successful device — if you do not appreciate its many applications — we urge you to study the Baker Section in the 1941 Composite Catalog; to send for an individual Baker Catalog; or have the nearest Baker representative give you complete and convincing details.

BAKER OIL TOOLS, INC.

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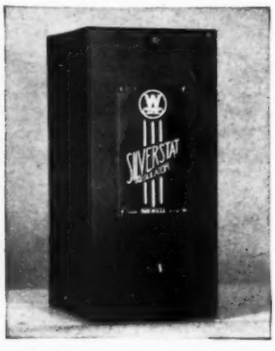
Central Division Office and Factory: P. O. Box 3048, Houston, Texas
Export Sales Office: 19 Rector Street, New York City

MACHINERY and EQUIPMENT

Voltage Regulator For Small Generators

FOR the automatic voltage control of small a-c. and d-c. generators, a new quick-acting rheostatic type regulator has been developed by the Westinghouse Electric and Manufacturing Company. Known as the Silverstat Junior Regulator, it is available in d-c. ratings to 25 kw. and a-c. ratings to 44 kva.

This regulator performs continuously, in an automatic and much quicker manner, the same operation as obtained by hand manipulation of the field rheostat of a machine under manual control, the manufacturers assert. The voltage of the machine to be regulated is connected across the regulator coil and any change in voltage results in a corresponding change in the magnetizing effect of the coil on the magnetic circuit. The attractive force on an armature will be increased or decreased causing the armature to seek a new position. This will either close or open in sequence an assembly of silver buttons to short out or insert steps of a carbon-plate resistor in series with the field circuit of the generator. This will keep the generator output voltage within 3 percent of normal.



Non-oxidizing silver buttons assure clean contacts and minimum wear. There are no parts requiring readjustment or replacement at frequent intervals, so little or no maintenance is necessary.

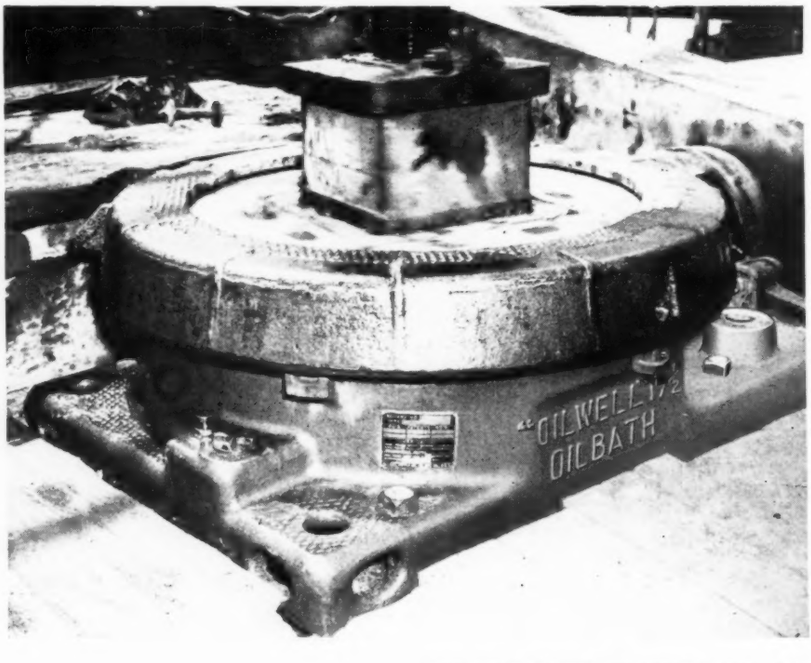
For more detailed information on the Silverstat Junior Voltage Regulator write to department 7-N-20, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

"Oilwell" 17½-in. Oilbath Rotary

OIL Well Supply Company, Dallas, Texas, now manufactures the new "Oilwell" 17½-in. Oilbath Rotary, recommended for speeds to 400 r.p.m. and a maximum drilling depth of 7500 ft. New features include a fully heat-treated, forged-steel, spiral-bevel gear train with the pinion given an additional surface hardening. The spiral-bevel design results in smooth and quiet operation and is especially suitable for high-speed service. The main bearing is of self-centering, high-speed, ball-and-race design with high-precision, large-diameter steel balls and surface-hardened, heat-treated and ground steel races. An extra-wide, heavy-duty, bronze radial and hold-down bearing is fitted low in the base for greatest steadying effect and maximum wear-resistance.

Circulating oilbath lubrication is provided for the gear train, main bearing, and hold-down bearing. These parts operate in a complete enclosure with a perfected labyrinth seal. The oil reservoir extends completely around the table. The hold-down ring forms a cylindrical container with the top overlapping the oil-retainer ring, assuring continuous circulation and complete return of the lubricant, the manufacturer asserts.

The large-diameter pinionshaft is a high-carbon steel forging, heat-treated for maximum toughness. It rotates in a double-row, heavy-duty tapered roller bearing and a heavy-duty straight roller bearing. These bearings are mounted in separate, cylindrical, steel housings that are solidly supported in circular bearing supports integral with the base, assuring, it is stated, perfect alignment at all times. Pinionshaft bearings are lubricated through Alemite connections, and the housings are provided with oil seals and pressure-relief fittings. Skids, table enclosure, oil reservoir, and pinionshaft bearing supports are integral with the rigid, one-piece, cast-steel base. The table top is flat and low, and is covered at its circumference by a reinforced steel guard with diamond-pattern safety tread and sloping sides. In addition to its safety feature, the guard prevents the slinging of mud onto the derrick floor.



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who will drill new wells in 1941:—

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*call today

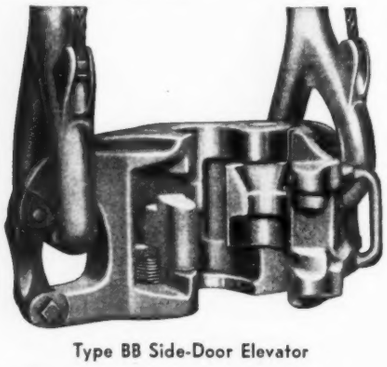
Byron Jackson Type BB Side-Door Elevator; Friction Trap Elevator

BYRON Jackson Company announces the development of a new elevator for handling strings of external upset drill pipe weighing to 300 tons. This Type BB Elevator is of the side-door type and is of extra-heavy construction, made of alloy-steel material, heat-treated to give maximum strength and to withstand shock loads.

The side-door acts as a strong connecting latch that prevents the body from spreading under the wedging action imposed by the external upset of the drill pipe when extremely heavy loads are carried. When the elevator is swung into position around the drill pipe below the upset a "closing finger" (which is integral with the door) causes the door to swing shut and latch automatically. As the load is taken, the upset fits into the recessed and tapered upper portion of the body where it remains until the load is relieved and the elevator is dropped below the upset. The T-head latch that locks the side-door, has a positive, horizontal action that is not affected by vertical jars and shocks, the manufacturer asserts. A curved end on the latch facilitates easy opening when the load has been relieved.

A rear handle, integral with the body, contributes to the safety and speed of handling the elevator by offering a convenient way to swing the elevator on and off the pipe.

The BJ Type BB Side-Door Elevator is regularly supplied for external upset drill pipe, having the standard 18 deg. angle, but can be bored to meet other specifications.

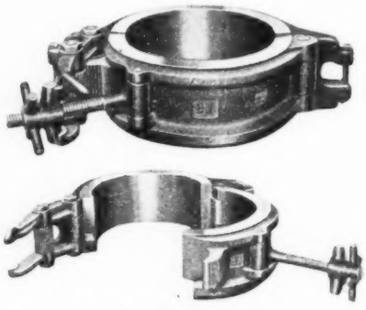


Type BB Side-Door Elevator

Byron Jackson is also offering a friction grip elevator for handling surface casing, or large diameter water strings when the load is not too great.

The design of the body and door is similar to that of the standard BJ Side-Door Elevators; however, as the type of casing to be handled has no collars, it is necessary that the elevator have a powerful, evenly distributed friction grip. This has been accomplished by means of a machined inner bore (which may be wickered) and a special latch and take-up mechanism. The latching device consists of a built-in pinion roller that meshes over an eccentric rack cast into the door. The tighter the latch is clamped the more firmly the elevator grips the casing because of the tightening effect of the eccentric rack. This gripping action is controlled by the take-up screw that pulls the latch inwardly toward the pipe. A cross-arm washer on the take-up screw fits into a saddle-like recess in the latch, so that the take-up screw can be unfastened only by unscrewing the take-up screw nut. Jars and blows will not cause it to release.

The BJ Friction Grip Elevator is made to order only, as the inner bore must be machined to accommodate the type of surface casing to be handled.

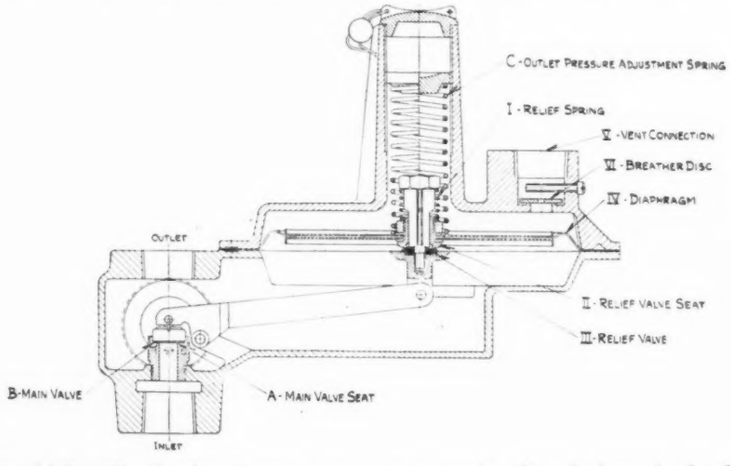


BJ Friction Grip Elevator

Further information can be obtained from Byron Jackson Company, P. O. Box 2017, Terminal Annex, Los Angeles, California.

Emco Service Regulator With Internal Relief Valve

THE Pittsburgh Equitable Meter Company has announced that its Emco Type B Ejector Service Regulator can now be supplied equipped with an internal relief valve. According to the manufacturer, it is extremely important that service regulators, whose principal function is to reduce higher distribution pressures to pressures suitable for meter and house piping, perform this task of reducing with a maximum of safety. The purpose of the internal relief valve is to prevent pressures in excess of those for which the regulator is set from reaching the house lines.

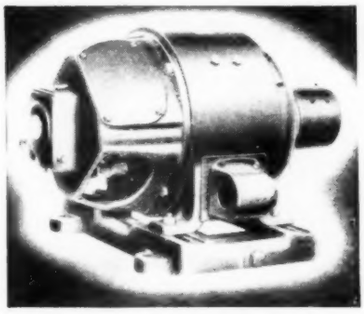


Operation of this device is explained by referring to the accompanying illustration. In normal operation, as a pressure regulator under standard conditions, spring I operates to hold valve III on seat II. Spring I is a heavy, non-adjustable spring, and can exert a very strong force to insure a tight closing of the valve III, on soft seat II. If because of dirt on the main regulator valve, or a nicked seat, main valve B fails to close, pressure will build up under the main diaphragm IV, above the normal lock-off pressure. When this pressure increase, multiplied by the area of the large diaphragm IV, is sufficient to overcome spring I, valve III is raised off its seat, and the excess pressure is relieved through the fluted area of valve III, into the top diaphragm chamber. Thence, this gas flows out through vent connection V, by raising breather disk VI. Obviously, vent connection V must be piped to a safe place for the venting of unburned gas. On relieving this excess pressure, spring I will close the valve. Valve III is guided accurately to its seat, thus assuring a positive shut-off.

The Pittsburgh Equitable Meter Company has issued a descriptive bulletin, No. 1065, which will be sent upon request to the manufacturer at 400 North Lexington Avenue, Pittsburgh, Pennsylvania.

General Electric's New Line of D-C. Motors

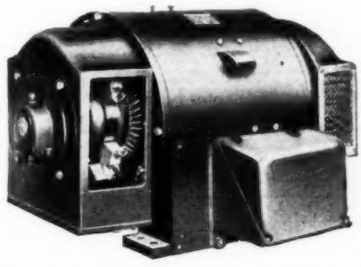
COMPACTNESS and improved protection are two outstanding features of a new line of d-c. motors recently announced by General Electric Company, Schenectady, New York. A new design of rolled-steel frame and improvements in end-shield and bearing-bracket construction combine to give the new motors excellent protection from external damage. The use of Formex wire coils and a specially developed Glyptal insulating



New d-c. motor typical of smaller ratings

varnish provide high resistance to impact, abrasion, and the action of foreign materials. The motors can be supplied with sleeve or ball bearings.

Open motors are available in constant-speed ratings from ½ hp. at 850 r.p.m. to and including 60 hp. at 1750 r.p.m., and, in adjustable-speed ratings from ½ hp. at 850/3400 r.p.m. to



New d-c. motor typical of larger ratings

and including 15 hp. at 500/1800 r.p.m. Motors in the larger ratings (beginning at 50 hp., 850 r.p.m.) embody additional design innovations such as a new system of self-ventilation, extra protection of all current-carrying and rotating parts, and large conduit boxes. New V-type double-brushholders give better commutation and permit rotation in either direction and a new type lifting lug facilitates handling.

Other features common to the entire line include lower WR^2; small diameter, which means low headroom; reversal without changing any parts of the frame, fan, or brush rigging; and Textolite wedges in the armature slots to protect the windings.

Flue Rolling Machines

INGERSOLL-RAND Company has introduced two new flue rolling machines, sizes 55-Q and 55-R. Both machines are powered by a "multi-vane" type air motor.

The machines are reported to be extremely powerful, having been built especially for rolling extra large tubes as used in oil refinery stills; tapping for, running in, or removing large pipe plugs; tapping flue sheets in large boilers; heavy reaming such as in propeller shaft coupling, and for practically any extra-heavy work of similar nature.

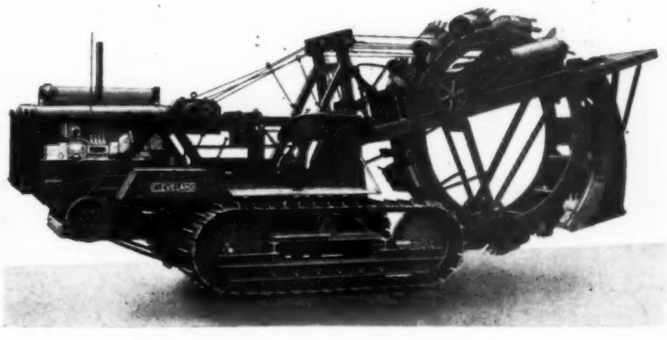
The manufacturer states that the working speeds of these machines are very low with correspondingly high torque. The size 55-Q has an average working speed of 32 r.p.m. The size 55-R has an average working speed of 20 r.p.m. and approximately 50 percent greater torque than the 55-Q.

For further details address all communications to Ingersoll-Rand Company, 11 Broadway, New York, New York.

ON YOUR NEXT JOB . . .

GET BOTH { FOOTAGE and ECONOMY } with

CLEVELANDS



When you buy "Clevelands" you get the most for your money, because they give you BOTH Performance AND Economy.

PERFORMANCE—because they have the power to conquer tough digging conditions with the speed to maintain high daily footage.

ECONOMY—Because the strength and the supreme excellence of their construction means long life and low operating costs.

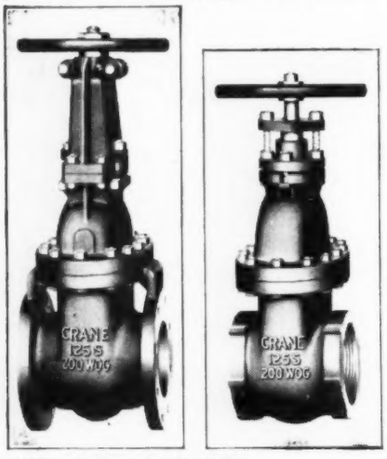
"Clevelands" . . . your best buy . . . give you BOTH

THE CLEVELAND TRENCHER COMPANY

20100 ST. CLAIR AVENUE — *"Pioneer of the Small Trencher"* — CLEVELAND, OHIO

New Line Iron Body Wedge Gate Valves

A NEW and complete line of standard iron body wedge gate valves for 125-lb. steam, 200-lb. cold working pressure has been brought out by Crane



LEFT — O. S. & Y. FLANGED.
RIGHT — NON-RISING STEM, SCD.
STANDARD IRON BODY WEDGE GATE VALVES

Co., Chicago, Illinois. This new line includes both the brass-trimmed and the all-iron patterns with O.S.&Y., or non-rising stem, in sizes 2- to 12-in., inclusive. Also, the quick opening and the Underwriters' patterns, the alloy-trimmed, alloy-cast-iron valves for process work, and the standard iron body valves for marine cargo oil systems.

Among the important features of these new valves is the redistribution of body and bonnet materials, which eliminates all excess weight and yet complies with all standard requirements. Handwheels are of strong malleable iron; deep stuffing boxes permit a generous amount of packing; the body-bonnet joints employ a flat gasket and are closely bolted together so that gasket compression is evenly distributed; seat rings are of the shoulder type to retain tight contact with the body in spite of the difference in expansion characteristics; stems, threads, bolt holes, nuts and bolts, in fact, all machined parts, are precise in their fit and finish, which reflect the careful workmanship and high quality built into them, the manufacturer asserts.

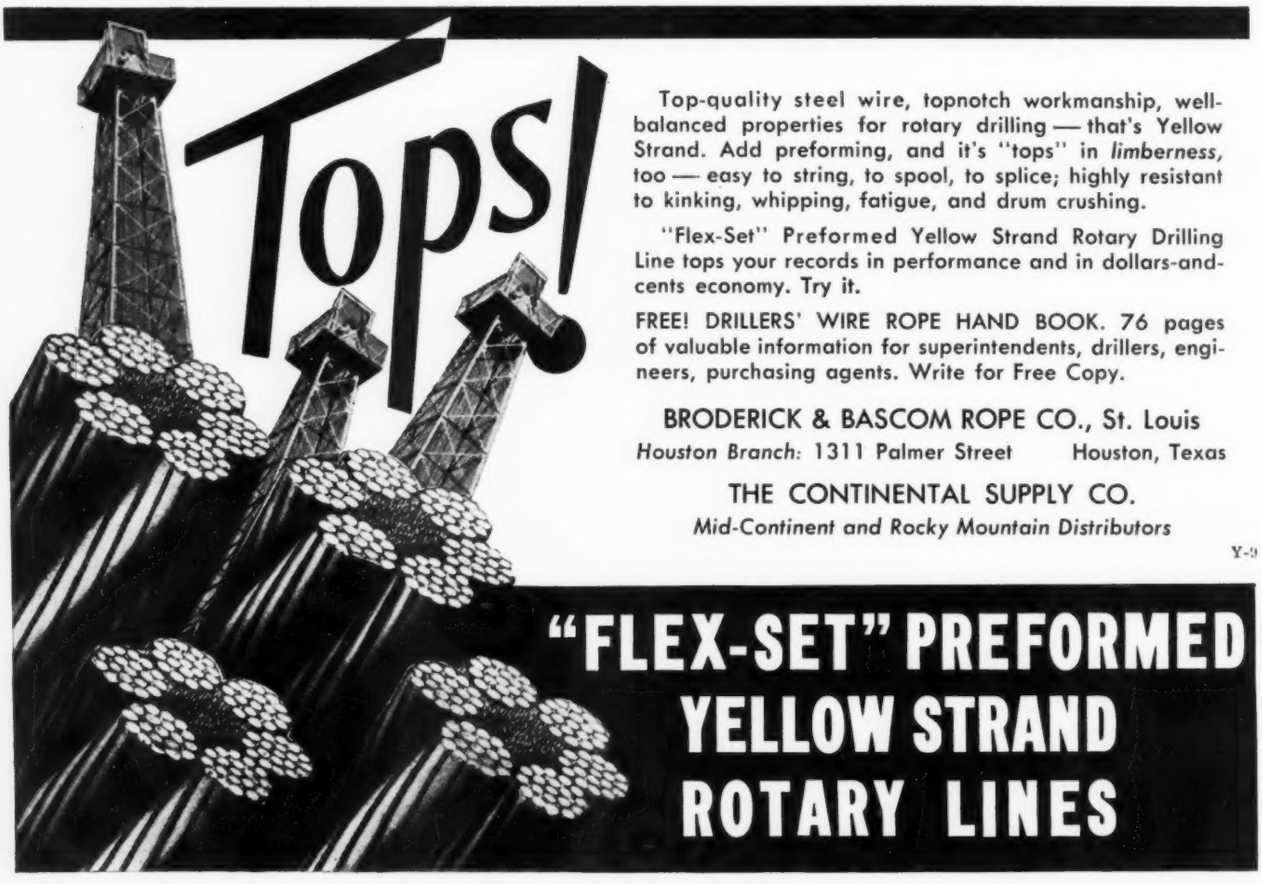
This complete line is illustrated and described in detail in a new booklet (No. A. D. 1452), which will be mailed on request. Address any Crane branch, or Crane headquarters at 836 South Michigan Avenue, Chicago.

Benjamin "Stream-Flo 60"

A NEW Benjamin fluorescent lighting unit to utilize the extra light advantages of the new 60-in. fluorescent lamps and embodying a new Stream-Flo development to provide for ceiling illumination, has been announced by the Benjamin Electric Manufacturing Company, Des Plaines, Illinois.

This new unit, known as the Benjamin RLM "Stream-Flo 60," has all the operating and design advantages of the Benjamin "Stream-Flo 48." In addition, the unit is available with a series of apertures placed in the top of the reflector directly over each fluorescent lamp. These openings permit approximately 2½ percent of light output to pass upward to relieve contrast between lighted areas of the room and the ceiling background. By utilizing the new 100-watt, 60-in. fluorescent lamps, this unit extends the scope of practical fluorescent lighting applications by providing the higher levels of illumination required in many industrial locations, it is stated by the manufacturer.

In announcing the new unit, the Benjamin company states: "This new


Tops!
Top-quality steel wire, topnotch workmanship, well-balanced properties for rotary drilling — that's Yellow Strand. Add preforming, and it's "tops" in *limberness,* too — easy to string, to spool, to splice; highly resistant to kinking, whipping, fatigue, and drum crushing.
"Flex-Set" Preformed Yellow Strand Rotary Drilling Line tops your records in performance and in dollars-and-cents economy. Try it.
FREE! DRILLERS' WIRE ROPE HAND BOOK. 76 pages of valuable information for superintendents, drillers, engineers, purchasing agents. Write for Free Copy.
BRODERICK & BASCOM ROPE CO., St. Louis
Houston Branch: 1311 Palmer Street Houston, Texas
THE CONTINENTAL SUPPLY CO.
Mid-Continent and Rocky Mountain Distributors
Y-9
"FLEX-SET" PREFORMED
YELLOW STRAND
ROTARY LINES

RLM 'Stream-Flo 60' provides adequate levels of lighting for those industrial locations that require higher mounting and wider spacing than has heretofore been considered practical for fluorescent units. It provides twice as much light as the Benjamin 'Stream-Flo 48,' thus approaching the goal of 50 ft.-candles of general fluorescent lighting from installations with 10 by 10 ft. spacing.

"Adequate protection against glare is provided by a shielding angle of 14° and closed-end reflector construction. By providing widespread light distribution the 'Stream-Flo 60' assures good illumination on both horizontal and vertical surfaces with minimized glare and shadow. Due to greater diameter and length, the 60-in. lamps used in this unit have only about 25 percent more surface brightness than 48-in. lamps yet produce twice as much light. Thus, highly desirable brightness values are maintained.

"Utilizing the same fused porcelain enamel reflecting surfaces as other Benjamin Stream-Flo units, the 'Stream-Flo 60' has a reflection factor of 79 percent or more.

"The new unit is designed to use two 60-in., 100-watt 'white' fluorescent lamps with 3500° Kelvin rating equal to a 'daylight' incandescent lamp in color temperature. It is available either with or without the apertures in the top of the housing."

Complete details on the construction and lighting advantages of this new Benjamin RLM "Stream-Flo 60" unit can be obtained by writing for descriptive catalog sheets No. "60" and mentioning that you saw the news item in *The Petroleum Engineer*. Address: Benjamin Electric Manufacturing Company, Des Plaines, Illinois.

New Free-Machining Alloy Combines Four Features

AN addition to the group of high nickel alloys has been announced by The International Nickel Company, Inc. It has high strength, can be fabricated in automatic screw machinery, resists corrosion, and can be heat-treated after fabrication to provide an extra measure of strength and hardness, it is stated. The alloy is being produced in rod and wire forms only.

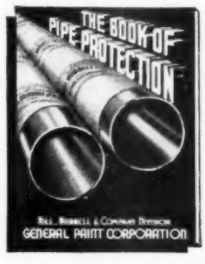
"KR" Monel represents the culmination of a development to make available a metal that would offer machining characteristics together with physical properties similar to "K" Monel. Like "K" Monel, "KR" Monel is non-magnetic, thus also fitting it for service in industries where resistance to magnetic influences is important.

Being a non-ferrous alloy with the same composition as "K" Monel and Monel, it provides the characteristic corrosion resistance of these metals. It derives its free-machining qualities from special thermal treatment at the mill before shipment to the user.

PROPERTIES OF "KR" MONEL RODS

	Yield strength 1000 lb. per sq. in.	Tensile strength 1000 lb. per sq. in.	Elongation percent in 2 in.	Hardness BHN 3000 kg.
Hot rolled	40-85	90-120	45-30	140-225
Hot rolled, age hardened	90-120	135-160	30-20	260-300
Cold drawn	70-100	100-125	35-15	175-250
Cold drawn, age hardened	100-130	140-170	30-15	260-320

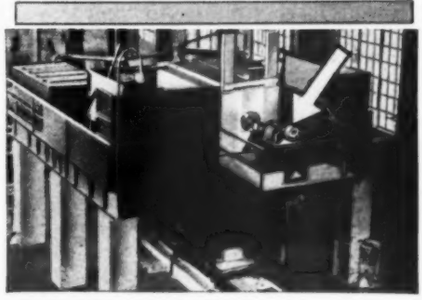
ENGINEERS PREFER
The HILL-HUBBELL "factory process"



A request on your letterhead will bring a copy of "Pipe Protection" which describes our process in detail.

Buy STEEL PIPE Mill Coated-and-Wrapped at any of these Mills
Jones & Laughlin Steel Corporation
National Tube Company
Republic Steel Corporation
Spang Chalfant, Inc.
The Youngstown Sheet & Tube Company

Engineers prefer the HILL-HUBBELL "factory process" for Coating-and-Wrapping STEEL PIPE because the best material won't protect unless it is PROPERLY applied. The HILL-HUBBELL "factory process" is, without question, the most effective method known today for applying Pipe Protection. All work is done INDOORS under ideal conditions. It is done MECHANICALLY which assures maximum efficiency. The HILL-HUBBELL "factory process" costs no more.



For maximum protection, material must be at the PROPER temperature the INSTANT it is applied. Our STATIONARY Kettles are equipped with Automatic Temperature Control to protect coating materials from destructive overheating. They are also equipped with motor-driven Mechanical Agitators to keep mineral fillers in constant suspension.

Schematic Construction of Specification TAX-1

GENERAL PAINT CORPORATION
HILL, HUBBELL & CO. • Division • Cleveland, Ohio
• EXPORT OFFICE SAN FRANCISCO, CALIFORNIA U S A •

Adds to Line of Oil-Tool Jewelry

AMONG the recent additions to the line of oil-tool jewelry created by J. B. Walker Manufacturing Company are the rotary bits shown herewith in actual size. These miniature reproductions of real drilling tools are accurate in every detail; the cutters and reamers rotate freely and all dimensions are to scale. The company is headed by J. B. Walker, a practical oil man with more than 30 years' field and oil-tool experience, and manufactures miniature rotary rock bits and reamers, as well as kelly joint or drill pipe tie holders (with rotary bits or reamers attached) in either chrome or gold-plated finish. Miniature reproductions of other oil-field equipment are made to special order.

An illustrated folder containing prices is available from J. B. Walker Manufacturing Company, 430 South Union Avenue, Los Angeles, California.

Vertical Explosion-Proof Motors

U. S. ELECTRICAL Motors, Inc., Los Angeles, California, and Milford, Connecticut, has recently developed a vertical explosion-proof motor. The new unit is suitable for vertical applications in both Class I, Group D, and Class II, Group G locations as defined by the National Board of Fire Underwriters. The first class are those locations in which flammable volatile liquids, highly flammable gases, mixtures or other highly flammable substances are present. The second class includes locations in which combustible dust is present as in flour or feed mills, grain elevators, starch plants, sugar, cocoa, and coal pulverizing plants.

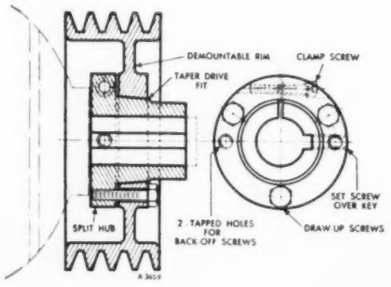
The unit is fan-cooled and has asbestos-protected windings that are especially important as explosion-proof motors are rated 55°C. rise or 37 percent higher than standard motors.

These vertical explosion-proof motors are offered with a variety of mounting flanges and regardless of the design of the machine, a mounting bracket is available to fit it without additional adaptors or plates.

Write for Unimount solid shaft bulletin to U. S. Electrical Motors, Dept. 106, 80-34th Street, Brooklyn, New York.

Quick-Detachable Sheaves For V-Belt Drives

A NEW type of V-belt driver sheave, designated as the Q-D quick detachable and quick demountable type, is announced by Worthington Pump and Machinery Corporation,



Harrison, New Jersey, as a standard item in its Multi-V-Drive line. Extreme simplicity of construction is claimed, and suitability for any application where quick mounting of sheave to shaft, and dismounting from shaft, are desirable; for example, on those classes of equipment where speed ratios must be changed to meet varying conditions. Applications cited are fans, blowers, printing presses, machine tools, and special equipment in the petroleum, paper and textile industries. Also, in general maintenance, it eliminates the necessity of a wheel puller to remove wheel or hub from shaft.

Each sheave unit consists of two parts, a longitudinally-split or clamp hub and a V-grooved rim. The hub is clamped to the shaft by means of a cap screw in its flange and is securely fastened by a standard keyway. A fit equal to a press fit, on shafts to ten thousandths over-size or under-size, is provided. The rim is taper-fitted to the hub and is fastened with three draw bolts.

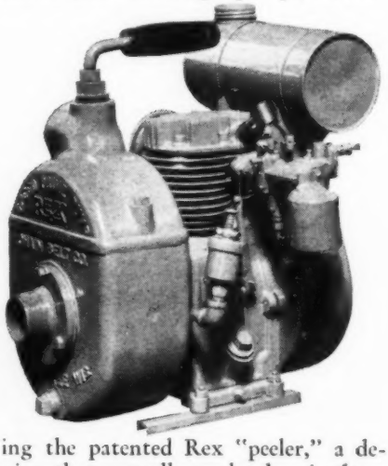
To remove the rim, the draw bolts are withdrawn and two of them are inserted in holes so tapped in the rim that the bolts act as jamb screws and bear against the hub, thus forcing the rim off the taper without disturbing the position of the hub. No pounding or prying is required to remove either the rim or the hub. With this equipment, it is asserted that the dangers of battered motor bearings, bent shafts, broken sheaves, and human injury are eliminated.

The type Q-D sheaves are available in the complete range of standard driver sizes and are stocked at convenient points. Descriptive literature will be supplied upon request to the manufacturer.

"Rex Junior" Centrifugal Pump

CHAIN Belt Company, Milwaukee, Wisconsin, announces the manufacture of "Rex Junior," a new, lightweight, 3000 gal. per hr. centrifugal pump weighing only 54 lb.

This 1½-in. pump contains all the engineering features of the standard line of Rex centrifugal pumps, includ-



ing the patented Rex "peeler," a device that actually peels the air from the whirling impeller and thus speeds up the prime. It has a large semi-steel recirculating water chamber equipped with an aluminum cap to save weight and is powered by a dependable, easy starting single-cylinder, air-cooled engine of ¾ to 1 hp.

The engine is equipped with an automatic governor that speeds-up the motor when the pump catches its prime and starts to lift water. This eliminates the possibility of putting too much strain on the power unit at low speeds.

The overall dimensions of 15¼ in. long by 11¾ in. wide by 15¾ in. high, combined with a weight of only 54 lb., make it possible to pick-up "Rex Junior" with suction and discharge hose still attached.

Wagner Noflamol Transformer

WAGNER Electric Corporation announces a new type transformer known as the Wagner Noflamol Transformer. Noflamol is a non-inflammable synthetic liquid developed as an improvement over regular transformer oil, the manufacturer asserts. Because of the non-inflammable characteristics of Noflamol, these transformers can be installed indoors without the use of fireproof vaults. In addition to this saving on installation expense, several other advantages are set forth by the manufacturer. For additional information write direct to the Wagner Electric Corporation, 6400 Plymouth Avenue, St. Louis, Missouri.

W. D. Murphy Joins Advertising Agency Staff

W. D. Murphy, advertising manager of Sloan Valve Company and vice-president of the National Industrial Advertisers Association, joined Reincke-Ellis-Younggreen and Finn, Chicago, Illinois, advertising agency, as of January 1, in an executive capacity.

In making this announcement, A. B. Reincke, head of the advertising agency, said he admired the constructive program of the N.I.A.A., and had been impressed by the work of the Committee on Professional Development, of which Murphy has been the chairman since 1938. Reincke also expressed his appreciation to W. E. Sloan, president of Sloan Valve Company, for accepting Murphy's resignation at this time, thereby enabling him to augment the agency staff with a man of wide experience and national recognition.

Del Valle Gasoline Plant Nearing Completion

Erection of a natural gasoline plant for the Del Valle Gasoline Company on its lease 3 miles west of Castaic, California, is now under way, according to the announcement made jointly by R. E. Havenstrite and R. E. Bering of that company. Parkhill-Wade, Los Angeles, consulting and construction engineers, are in charge of operations.

The plant is designed to handle a maximum of 20,000,000 cu. ft. of natural gas per day at 450 lb. per sq. in. working pressure with a lean oil circulating rate of 125 gal. per min. The daily distillation and stabilization capacity of the plant is 15,000 gal. of 26-lb. Reid finished gasoline.

The plant will include a vapor-recovery system. Among its other features will be compact plant layout, automatic plant control, audible alarm signals, and a patented Parkhill-Wade stabilizer cycle.

The main compressors and vapor-recovery system will, in effect, make this a three-stage plant. Incoming gas from the field trap will pass through a scrubber and into the first compressor stage at 25-lb. suction, go through the cooling tower, a second scrubber, and through the second stage, where the pressure is increased to 450 lb. per sq. in. After passing through an orifice meter, the wet gas will then enter the absorber.

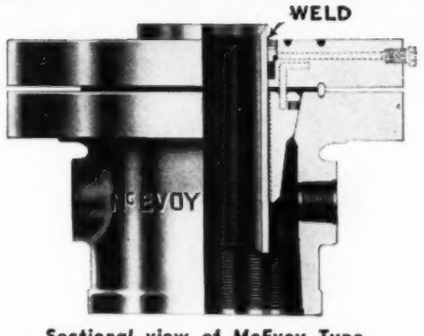
The vapor recovery system will take gas off the top of the crude gauge tanks at atmospheric pressure, pass it through a compressor to increase its pressure to that coming from the field trap, which it will join upstream from the main compressor installation.

The absorption tower will be unusual in design as it will be a combination of three plant units in one shell. The base section of the tower will contain an inlet scrubber; the central section, a 16-plate bubble-cap absorber, and the top section, an outlet scrubber. This feature makes possible a substantial saving in piping costs and results, as well, in a material saving of plant yard space.

The stabilizer circuit is so arranged that only the amount of reflux required by the column is condensed; the excess being discarded to stack as a warm vapor. The entire plant will be automatic in operation after manual setting of the lean oil circulating rate. This will be accomplished by liquid-level controls. Augmenting the automatic control feature of the plant, as well as to make it as fool-proof as possible, alarms with audible signals will be installed. These will include high-level alarms on the high- and low-pressure vent tanks, the scrubbers, low-pressure on the lean oil discharge, the plant pilot supply system, the cooling water discharge with both high- and low-level alarm on the boilers.

The plant is being erected by Parkhill-Wade on a turnkey basis, ground having been broken November 12 and delivery is scheduled for some time this month.

A Really ★★ SAFE CASING HEAD for DEEP WELLS



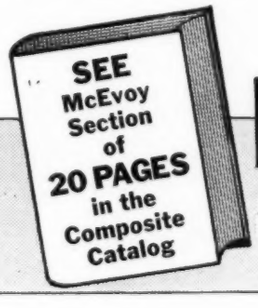
Sectional view of McEvoy Type LWSE Casing Head showing slips and welding flange with hydraulic packing

You are safe from costly leaks and casing failures when McEvoy Type LWSE Casing Heads support your long casing strings.

Casing is quickly and accurately set — Slips hold the casing at *exactly* the right tension. Weld and extra packing assure a positive seal. No time is lost in cutting spacing nipples — no more casing failures — you set every string quickly and safely with this casing head.

Perfect seal between strings—You test the seal *before* adding the next section. Pressure is applied between packing and weld to show up any leak.

Proved. Many of the longest strings in the world are supported by McEvoy Type LWSE Casing Heads. If you are starting a deep well be sure to try this trouble-saving casing head. Call McEvoy Company or your favorite supply store.



McEVOY COMPANY
TEXAS AT MILBY
HOUSTON, TEXAS
EXPORT OFFICE: 30 CHURCH ST., NEW YORK

S. J. Dickey Becomes Head General Petroleum Corp.

Official announcement of the retirement of A. L. Weil from the presidency, and the election of S. J. Dickey to succeed him, has been made by General Petroleum Corporation of California. Announced also is the election to the board of directors of Fred Isaacs, manager of the company's Mobilgas refineries, and R. L. Minckler, assistant to the president.

Samuel Jackson Dickey, newly elected president, has been associated with General Petroleum for 21 years, having first joined the company in 1919 as refinery engineer. In 1920 he was made chief engineer; in 1927 he was elected a director, and in 1930 he was made vice-president in charge of manufacture.

Dickey was graduated in 1904 from the University of Pennsylvania, with the degree of B.S. in M.E., and on graduation received the Sigma Xi honorary fraternity election. He is also a member of the American Society of Mechanical Engineers, American Petroleum Institute, and Army Ordnance Association.

Previous to his affiliation with General Petroleum Corporation, Dickey experienced broad service in various engineering capacities, first during school years with the Pennsylvania Railroad, Bell Telephone Company, and University of Pennsylvania. For eight years after his graduation, Dickey served as traveling plant efficiency engineer, superintendent of development work, etc., for the United States Improvement Company of Philadelphia. In 1912 he was appointed engineer and superintendent of Syracuse Lighting Company of Syracuse, New York, where he directed design, installation, and operation of a toluene plant, to make toluene from manufactured gas for the production of TNT. This led to his appointment by the War Department to direct installation of toluene plants on the Pacific Coast.

Retiring President A. L. Weil, one of the most widely known men in the oil industry, has experienced a long and colorful career in the oil industry, which dates back to his graduation from the University of California in 1899; for more than 30 years he has been affiliated with General Petroleum Corporation.

H. L. Putnam Advanced By National Supply

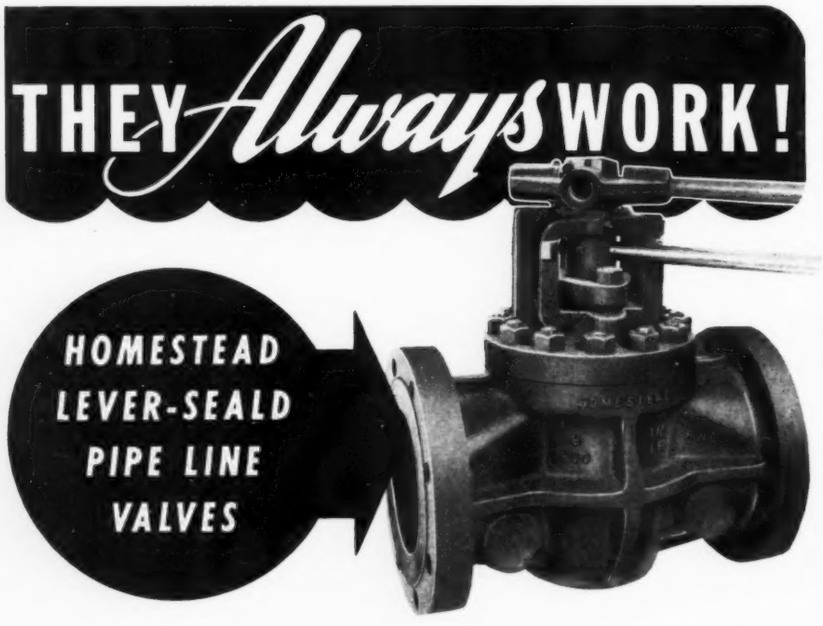
H. L. Putnam, division sales manager for The National Supply Company at Fort Worth, Texas, since 1939, has been transferred to Tulsa, Oklahoma, as assistant division manager of the Oklahoma Division.

Putnam has been affiliated with The

H. L. PUTNAM

National Supply organization since 1929, when he joined the company's sales staff at Torrance, California. In 1934 he was placed in charge of engine sales on the Pacific Coast and continued in this capacity until his transfer to Houston, Texas, in 1937 to engage in

THEY Always WORK!



You need never worry about how corrosion, long periods of idleness, or high pressure will affect the operation of your pipe line valves, when you use this new Homestead Lever-Seald Valve. It gives quick, positive opening or shut-off under all conditions. Made of semi-steel; 6-inch, 8-inch, and 10-inch sizes, for 800 pounds oil, water, or gas working pressure. Face-to-face dimensions same as those of gate valves for easy changeover. Order a few now, and let performance prove that these are the really trouble-free, lowest-cost-per-year valves for all of your pipe lines.

HOMESTEAD VALVE MFG. COMPANY
P. O. BOX 16 CORAOPOLIS, PA.

HOMESTEAD VALVES

Send for Valve Reference Book No. 38; and for special quantity prices on your valve requirements.

sales work in the Texas and Gulf Coast areas.

In May, 1938, Putnam assumed charge of National's sales staffs in Texas as division sales manager and continued in this position until his recent appointment.

A. W. Leonard, President Devonian Oil Co., Dies

Archibald W. Leonard, president of the Devonian Oil Company, died of a heart ailment at his home in Tulsa, Oklahoma, on January 7. He was widely known and respected throughout the oil industry, the company of which he was head being one of the largest independent producers in the United States.

Leonard attended Notre Dame University and immediately upon leaving

A. W. LEONARD

school entered the oil business as a salesman for the National Supply Company. Later he became a tool dresser and driller and then a contractor before becoming connected with the Devonian Company. With the latter he worked in West Virginia, Ohio, and Pennsylvania before going to Tulsa in 1904. He later severed his connection with Devonian and helped organize the Oklahoma Natural Gas Company. He was made a director of the company in 1916 and a vice-president in 1922. He also helped organize the Hinderliter Tool Company and at one time was its president.

Leonard became president of the Devonian Oil Company two years ago upon the death of J. H. Evans.

Death Takes George Hathaway Taber

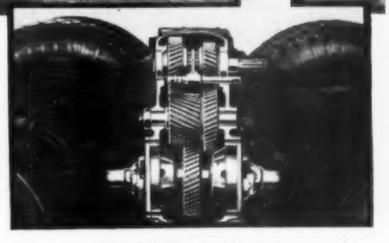
George Hathaway Taber, retired vice-president of the Gulf Oil Corporation, and a life-long friend of science, died at his home in Pittsburgh, Pennsylvania. Taber was born January 20, 1859, in Fairhaven, near New Bedford, Massachusetts. He entered the petroleum-refining industry in 1882 at the Queens County Oil Works in Brooklyn, one of the units of the original Standard Oil Company. While there he was responsible for the ultimately successful use of plate-and-frame filter presses in dewaxing chilled wax distillates, including the application of the hydraulic ram. Later he went to the Eclipse Works of the Atlantic Refining Company at Franklin, Pennsylvania, where he originated the centrifugal process for removing wax from cylinder stock-naphtha mixtures. Later he was superintendent of the Philadelphia Refinery of the Atlantic Company, where, again, he made important contributions to the technics of the industry, including the application of American (Florida) Fuller's earth for oil percolation.

In 1903 he left the Atlantic to become general manager of the Gulf Refining Company, and, later, vice-president in charge of manufacturing. It was in this position that he had a particularly intimate part in the founding of Mellon Institute.

Taber retired from active business in 1928.

HERE'S WHERE THE WORK IS DONE!

TRACTION . . . NOT POWER ALONE IS WHAT YOU NEED



★

When there's heavy work to do, TWO driving axles under the load are better than one. Use the

THORNTON FOUR-REAR-WHEEL DRIVE

YOU SAVE MONEY!

Take a truck of 1½ to 3-tons original capacity and let us quickly and at low cost convert it to a husky unit of 30,000 lbs. or more gross vehicle weight capacity.

Two ratios, for power and speed, easily controlled by a lever in the cab. Walking-Beam Flexibility—Special spring construction keeps equal load on all four driving wheels—Perfect balance between power and weight.

THORNTON TANDEM CO.
8701-8779 GRINNELL AVE. DETROIT, MICH.

Manufacturers also of the THORNTON automatic-locking DIFFERENTIAL which gives traction when slippery going makes trucks equipped with ordinary differentials helpless.

"When you need TRACTION you need THORNTON"

New Lane-Wells House Organ Format

"Tomorrow's Tools—Today," published by Lane-Wells Company, will appear in a new format beginning with the January, 1941, issue. The magazine, which has a circulation of 10,000 copies among oil company engineers and field operators, has published development articles about Lane-Wells gun-perforator, electrolog and oil-well survey services, and complete abstracts of all "drilling" and "production" papers appearing in current petroleum magazines. These two departments will be retained and new features will be added. Interesting stories and photographs, supplied by leading national outdoor publications, will appear regularly. Front cover plates will be reproductions of outstanding oil company house organs. A puzzle contest and a picture contest will be included.

"Tomorrow's Tools — Today" has been published regularly since 1934 and is considered by Lane-Wells as an important contact between the company and its customers.

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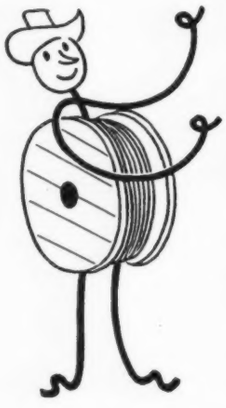

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DOPE on WIRE ROPE

No postage is required. Simply clip out the label above—paste to any card; write your name, your title, name of company and address on the other side, saying "Send me ROPE DOPE." It is not advertising and there is no charge for this periodical bulletin of current facts every wire rope buyer should know.

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The "ULTIMATE LOW COST WIRE ROPE"

Fluid Packed Pump Adds Two Mid-Continent Salesmen

O. L. Frame, southern Mid-Continent district manager for Fluid Packed Pump Company, Los Nietos, California, has announced appointment of R. E. Fuller and B. James Knight to the company's Mid-Continent sales force.

R. E. FULLER

Fuller joins Fluid Packed Pump Company as salesman after 7½ years in the employ of Mid-Continent Supply Company. Fuller worked out of the Lake Charles, Louisiana, and Houston, Texas, offices of that firm.

B. James Knight was at one time associated with the W-K-M Company.

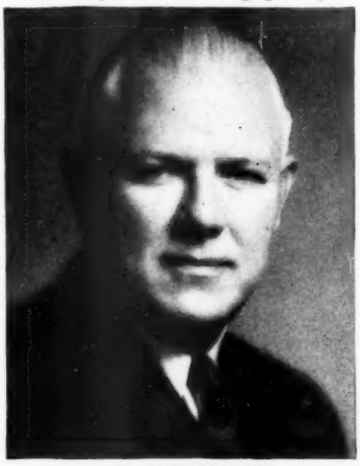
B. JAMES KNIGHT

He resigned after two years' service to join Schlumberger Well Surveying Corporation, where he was employed until his recent appointment to Fluid Packed Pump Company's sales department.

Both Fuller and Knight will have their headquarters at the Fluid Packed Pump Company Mid-Continent branch, 2 Southeast Twenty-Ninth Street, Oklahoma City, Oklahoma.

"Bert" Sutherland Joins Chaplin-Fulton

A. D. Sutherland, for some years connected with Lee C. Moore and Company as sales manager for its eastern territory, has been engaged by the



A. D. SUTHERLAND

Chaplin-Fulton Manufacturing Company as sales engineer in the marketing of their pressure control equipment.

Sutherland is well known to users of such equipment, especially in the oil and gas industries, in which he has been employed since 1910, with the exception of one year spent overseas during the first World War. Beginning as a tool dresser in Oklahoma, he participated in one capacity or another during the gas boom of the Cleveland field in Ohio and later in the McKeesport, Pennsylvania, field. He was for a time employed as a salesman for the supply house of Frick and Lindsey.

Stuart A. Giraud Passes Away

Stuart A. Giraud, a director of the Humble Oil and Refining Company,

STUART A. GIRAUD

and manager of the refining and sales departments of the company, died December 22 in a Houston, Texas, hospital after being ill three weeks.

Giraud was born in Houston March 28, 1887. At an early age he entered the oil industry with the Rio Bravo Oil Company, and a few years later transferred his affiliations to the Gulf Oil Corporation. He resigned in 1911 and opened offices in Houston as a certified public accountant. In 1915 he became comptroller of the Humble Oil Company, which was consolidated with the Humble Oil and Refining Company when the latter was organized in 1917. Giraud continued with the new organization and his services were uninterrupted except for a period during the first World War, when he was a lieutenant of artillery. After the war his advancement with the company was steady. He became manager of sales in 1932, chief administrative officer of refining in 1933, and in 1938 was made a director.

Hines H. Baker, a director of the company, succeeds Giraud. Baker is a graduate of the University of Texas. He opened a law office in Beaumont in 1918; in 1919 he became affiliated with the legal department of the Humble Oil and Refining Company. In February, 1937, he was made a director.

Sub Surface Control
OTIS
REMOVABLE
BOTTOM HOLE
REGULATOR
Control High Pressures, right from the start . . . at the bottom of the hole. Here, an Otis Removable Bottom Hole Regulator will safely reduce high pressure to safe workable limits. The natural formation heat offsets any temperature loss due to expansion . . . positively eliminating freezing at surface controls.
Rate of withdrawal can be increased or decreased by merely adjusting the surface choke. This effects a change in pressure differential across the regulator causing the opening through the regulator to automatically increase or decrease accordingly. This action permits a variable volume to be produced under a safe low predetermined surface pressure.
Hundreds of producers have learned the important advantages of Otis Bottom Hole Regulators for sub surface control. There is an Otis representative near you who will be glad to give you further details on the safe and economical Otis Methods of pressure control.
OTIS PRESSURE CONTROL, Inc.
DALLAS, TEXAS
PRESSURE CONTROL
OTIS
SERVICE - EQUIPMENT
"Don't Kill Your Well" Call OTIS

A. R. Weis, Director Dresser Mfg. Company

A. R. Weis, president and general manager of the Pacific Pump Works, Los Angeles, California, has been elected to the board of directors of the Dresser Manufacturing Company, Bradford, Pennsylvania, according to an announcement made by H. N. Mallon, president.

Weis has been identified for many years with the development of heavy-duty centrifugal pumps for power plant and oil refineries. He became president of the Pacific Pump Works, a wholly owned subsidiary of Dresser Manufacturing Company, in October, 1940, after serving as vice-president and chief engineer since the company's organization in 1924.

Pacific Pump Works manufactures Pacific centrifugal pumps for municipal, industrial, refinery, pipe-line, and hot-oil service, deep-well centrifugal turbines, and deep-well oil pumps. Dresser Manufacturing Company, the parent company, manufactures Dresser pipe couplings and pipe line repair devices. Clark Bros. Company of Olean, New York, manufacturers of compressors and gas engines, and Bryant Heater Company, Cleveland, Ohio, manufacturers of gas heating and air-conditioning equipment, are also subsidiaries of Dresser Manufacturing Company.

A. R. WEIS

R. L. Lerch Made General Sales Manager Haynes Stellite

Robert L. Lerch recently was appointed general sales manager of Haynes Stellite Company, unit of the Union Carbide and Carbon Corporation. Lerch has been associated with Haynes Stellite Company since 1924. During the first World War he served in the U. S. Marine Corps. After the war, he returned to Lehigh University, from which he was graduated in chemical engineering in 1922. He then spent a year and a half in various plant departments of the Bethlehem Steel Company's Lehigh Plant, Bethlehem, Pennsylvania. He joined the Haynes Stellite Company as a sales engineer in the New York district, later transferring to the Chicago territory, and next serving as district sales manager at Los Angeles and at Houston. Since 1929, he has been advertising manager and assistant to the general sales manager.

R. L. LERCH

PATTERSON-BALLAGH

PROTECTORS AVERAGING MORE THAN 5 WELLS

(10,000 FOOTERS)

In a study of a group of very deep wells in the Gulf area, 83 wells drilled to a total of 962,000 feet (including whipstocking footage) Patterson-Ballagh Protectors averaged more than 5 wells per string. The cost was considerably less than 4c per foot of drilling. There was not a single case of casing trouble, no water leaks, not a single fishing job in the casing, nor any instance of a "washout" in the casing. These are not wells selected because of their trouble-free record, but the deep wells in this district from which records could be obtained. Only one is less than 10,000 feet. Most of them are 13,000 feet deep. It's *Economy Insurance* to use these Protectors.

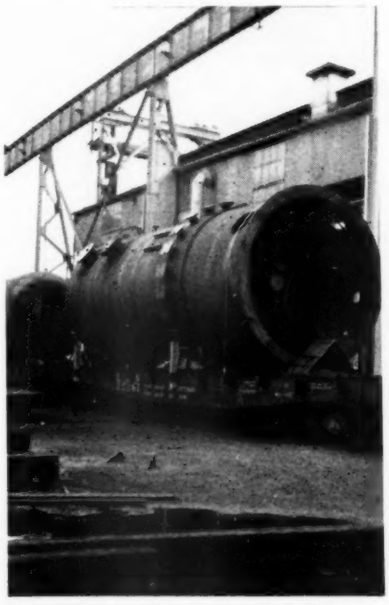
See 1941 Composite Catalog

PATTERSON-BALLAGH
CORPORATION

Los Angeles **Houston** **New York City**

Welded Pressure Vessels Shipped

Chicago Bridge and Iron Company, Chicago, Illinois, recently shipped



seven welded pressure vessels to Humble Oil and Refining Company at Baytown, Texas, from its Birmingham, Alabama, plant. One of the vessels, a 10-ft. diameter by 20-ft. reactor, is shown in the accompanying photograph loaded on a flat car ready for shipping.

Marmon-Herrington Creates Test and Proving Division

Announcement of the creation of a new Test and Proving Division has

G. H. FORD

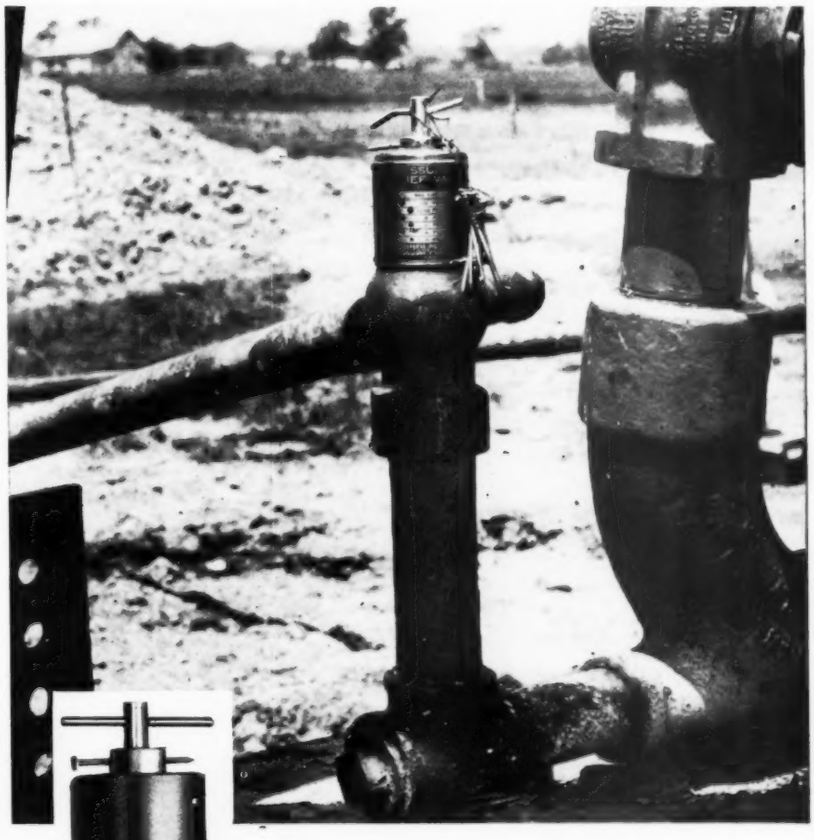
been made by the officials of the Marmon-Herrington Company of Indianapolis, Indiana, makers of All-Wheel-Drive trucks, tractors, and military vehicles. To head this newly created division the company has selected G.H. Ford, for many years chief timer at the Indianapolis Motor Speedway. Ford has timed practically all of the world's record speed trials conducted in this country.

In commenting on the creation of this new department, A. W. Herrington, president and chief engineer of the Marmon-Herrington Company, said: "This division is an entirely separate and independent division entrusted with the obligation of seeing that each new Marmon-Herrington model is capable of the particular performance for which it is intended."

Seminole Chapter A.P.I. Meets

The Seminole, Oklahoma, Chapter of the American Petroleum Institute held its monthly meeting December 16. The study subject for the evening was "Gravity Conservation," led by Clarence Glasgow, engineer for the National Tank Company, Tulsa, Oklahoma. Discussion was entered into by representatives of local companies.

A feature of the program was a talk by Rolley Inman, who has been ferrying bombers to England.



This Operator Won't Get Caught Short... He Keeps Spare Nails Handy!

Note, above, how the operator of this pump keeps his SHEAR-RELIEF Valve "repair parts" handy . . . a variety of nail sizes hanging by a cord from the valve stem. Should pump pressure reach the shear stress of the nail in the valve the nail shears and releases otherwise hazardous pressure. The operator merely pulls another nail from the spares and resets the valve. His table of pressures and nail shear stresses is on the valve nameplate. So is the nail gauge so that he won't mistake nail sizes.

FLUID-PISTON CLUTCH PUMPS
ABERCROMBIE PUMP CO.
GULF BLDG. HOUSTON, TEXAS

SHEAR-RELIEF VALVE

Carnegie-Illinois Steel and Oilwell Supply Announce Promotions

Leon F. Payne, treasurer of Oil Well Supply Company since 1929, has been appointed treasurer of Carnegie-Illinois Steel Corporation. He will make his headquarters in Pittsburgh, Pennsylvania, moving there from Dallas where "Oilwell" has maintained its general offices since 1932. Following graduation from Brown University, of which he is now an alumni trustee, Payne began his business career in 1907 with Western Electric Company. In 1909 he became associated with the sales department of Carnegie Steel Company, was made head of the credit department in 1918 and continued in that capacity until he joined "Oilwell" in 1929. He is widely known in the steel and the oilfield equipment industries and in banking circles.

LEON F. PAYNE

A. C. WIMMER

A. C. Wimmer succeeds Payne as treasurer of Oil Well Supply Company. Wimmer joined the "Oilwell" organization in 1916, and his association with the company has been interrupted only by his active service with the A.E.F. during the first World War. In 1932 he was made credit manager of the company's midwest division and later was appointed assistant treasurer.

Frank L. Wiegand has been appointed assistant treasurer. He has been connected with "Oilwell" since 1898 and has held several positions of responsibility.

FRANK L. WIEGAND

Both Wimmer and Wiegand are widely acquainted throughout the oil fields. They will continue to make their headquarters at Dallas.

1 SEAMLESS
2 UNIFORMLY FULL PIPE THICKNESS
3 ENGINEERED FOR UNIFORM STRENGTH
4 TANGENTS
TAYLOR FORGE
EACH one of these features guards against trouble and delay on the job. You'll find them combined only in WeldELLS
Seamless Pipe Fittings
WeldELLS
For Faster Easier Welding
TAYLOR FORGE & PIPE WORKS: General Offices and Works: Chicago, P. O. Box 485
New York Office: 50 Church St. Philadelphia Office: Broad Street Station Bldg.
5 MACHINE TOOL BEVELLED
6 ENDS MARKED IN QUARTERS
7 COMPLETE IDENTIFYING MARKS ON EVERY FITTING
8 A FULL LINE

SKF Again Expands

SKF Industries, Inc., Philadelphia, Pennsylvania, manufacturers of ball and roller bearings, is erecting an addition of 56,200 sq. ft. of manufacturing floor space to Plant No. 2, on the Pennsylvania Railroad at Bridge Street. This building is fireproof, sawtooth construction, conforming to the design of the main building.

In addition, a two-story brick wing enclosing 12,000 sq. ft. is extending office facilities at Plant No. 1, Front Street and Erie Avenue, bringing the total enclosed area of both plants to 666,600 sq. ft.

Illinois Basin Chapter A.P.I. Meets

One hundred and thirty-seven members of the Illinois Basin Chapter of the A.P.I. attended the fall meeting of the chapter held at Southern Gardens, Salem, Illinois, recently.

Ralph Hammond, electrical engineer of the Carter Oil Company, presented a paper entitled, "Electrification of Oil Field Equipment in Illinois." This paper discussed the method of electrification used by the Carter Oil Company.

The discussion, led by C. J. Haas of the Adams Oil and Gas Company, was participated in by a considerable number.

C. B. Jahnke Becomes Cooper-Bessemer President

The resignation of B. B. Williams as president of The Cooper-Bessemer Corporation, and election of Charles B. Jahnke as his successor, was announced following a meeting of the corporation's board of directors in Mount Vernon, Ohio.

C. B. JAHNKE

Williams was made chairman of the board of directors, succeeding Dr. E. J. Fithian of Grove City, Pennsylvania, who resigned his position. The new chairman expects to continue in an active capacity as the head of the corporation. Jahnke, who has been vice-president and general manager for the

B. B. WILLIAMS

last 2½ years, will act as president and general manager and will serve as a member of the executive committee. Dr. Fithian, one of the founders of the Bessemer Gas Engine Company, and its president for several years, will continue as a member of the board of directors.

The new president has been with the Cooper-Bessemer Corporation since 1935, having served 2½ years as chief engineer and since July, 1937, as vice-president and general manager. He came to Cooper-Bessemer as a Diesel engineer, with an extensive background and training in engineering work with that type of engine.

Reared at Cincinnati, Jahnke was graduated from the University of Cincinnati in 1910 and then worked for 21 years with Fairbanks, Morse and Company, at Beloit, Wisconsin, first as chief engineer and later as works manager of the Beloit plant. He later served as director of engineering after the Fairbanks-Morse management was changed to concentrate all activities of the company at Beloit. In 1931 he went to Chicago to join the International Harvester Company in its program of developing Diesel engines for farm machinery. Four years later he became affiliated with Cooper-Bessemer at Mount Vernon.

Williams, the retiring president, has been with the Cooper-Bessemer Corporation and its predecessor, the C. & G. Cooper Company, for 40 years. In 1900 he joined the Cooper Company as a sales engineer, and was made secretary in 1912. Four years later he became vice-president and general manager, and in 1920 was elected president, a position he retained when the Cooper Company was merged with Bessemer in 1929 to form the present corporation.

In becoming chairman of the board, Williams does not intend to retire into an inactive capacity, but plans to retain an active voice in the company's affairs and especially in shaping its broad policies, while turning over to the new president the actual administrative and organization work, along with the executive powers of the presidency.

Patten Heads Texas Oil and Gas Division

Dr. F. V. L. Patten was named chief of the Oil and Gas Division of the Texas Railroad Commission on January 1 to succeed John E. Taylor, who resigned to enter law practice in Austin.

Patten has been chief of production of the commission for more than two years. He holds three degrees from the University of Texas and has taught engineering in the College of Arts and Industries at Kingsville, Texas.

Opens Houston Office

Arthur G. McKee Company, Cleveland, Ohio, has opened an office in the Commerce Building, Houston, Texas. C. E. Moore, who has been manager of the London, England, office of the company for 12 years, only recently returning to the United States, is in charge.

WORLD'S CHOICE METHOD of RECONDITIONING ROTARY DRILLING MUD

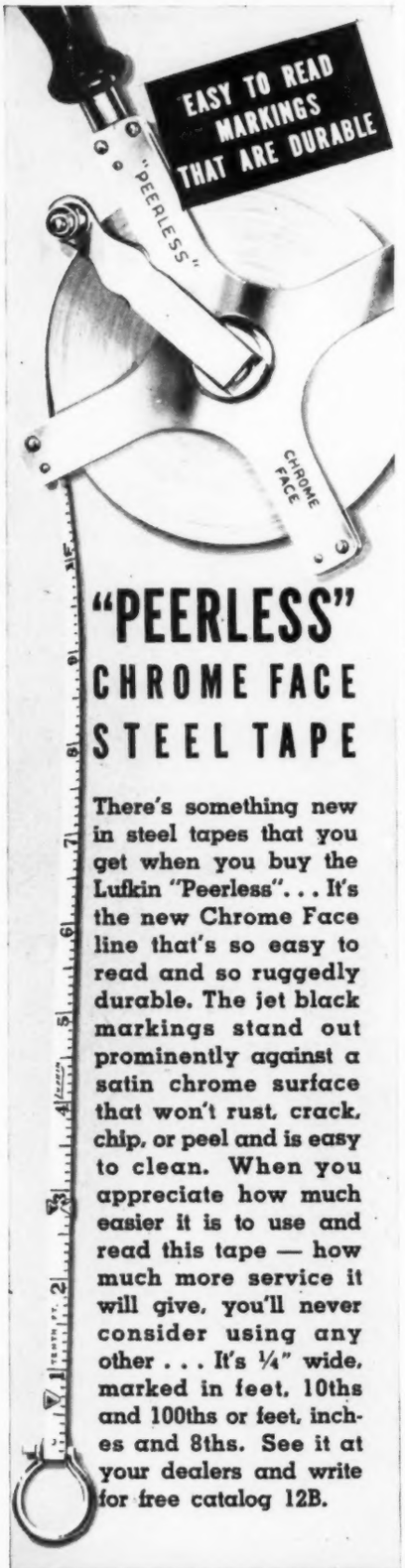
• The Link-Belt mud screen dual hook-up, pictured here in the field and used also as a single unit, is accepted worldwide as the latest and most efficient method of economically reconditioning rotary drilling mud. With its many new and exclusive features this advanced design is a result of Link-Belt's constant research and improvement since introducing the oil field's first vibrating screen more than 10 years ago.

The dual hook-up employs two 24" x 48" screens mounted on skids as one unit, with one mud collecting tank and inlet chute. A single turbine (or motor) drives both screens . . . handling the fluid of today's largest pumps . . . yet the screens operate independently when only one is required. *Write for detailed Folder No. PE-1872-A.*

LINK-BELT COMPANY Philadelphia, Houston, Dallas, Los Angeles, Kansas City, Mo., New York, Toronto. Sold by most supply houses. 8184A

LINK-BELT MUD SCREEN

• *Renew Your Subscription* •


EASY TO READ MARKINGS THAT ARE DURABLE
"PEERLESS"
CHROME FACE
"PEERLESS"
CHROME FACE
STEEL TAPE
There's something new in steel tapes that you get when you buy the Lufkin "Peerless"... It's the new Chrome Face line that's so easy to read and so ruggedly durable. The jet black markings stand out prominently against a satin chrome surface that won't rust, crack, chip, or peel and is easy to clean. When you appreciate how much easier it is to use and read this tape — how much more service it will give, you'll never consider using any other . . . It's ¼" wide, marked in feet, 10ths and 100ths or feet, inches and 8ths. See it at your dealers and write for free catalog 12B.
LUFKIN
SAGINAW, MICHIGAN · New York City
TAPES · RULES · PRECISION TOOLS

J. B. Kissinger Retires

J. B. Kissinger, auditor of Oil Well Supply Company's California Division, retired on December 31, after 45 years' service with "Oilwell." Kissinger entered the employ of the company at Oil City, Pennsylvania, in 1895. Since 1909 he has been connected with "Oilwell's" Pacific Coast activities, headquartering in Los Angeles.

J. B. KISSINGER

Pennsylvania's School of Mineral Industries

A recent issue of *Mineral Industries*, published by Pennsylvania State College, is devoted to a discussion of the program and physical plant of the School of Mineral Industries. Its purpose is to give a better idea of the philosophy back of the unified program of the school and of the services being rendered to the mineral industries, especially in Pennsylvania.

That portion of the publication devoted to "Petroleum and Natural Gas" is quoted:

"Pennsylvania is the birth-place of the petroleum industry. At present 75 percent of the oil refined in Pennsylvania is imported into the State. On the other hand, Penn Grade Crude is a premium 'black gold' that makes preferred lubricants which are marketed around the world.

"The work in petroleum and natural gas embraces all fields of activity: geological and geophysical exploration, drilling and development, production and transportation, processing, utilization and distribution. Strong emphasis is placed on improving oil production practices; the two billion barrels remaining underground in Pennsylvana, unrecoverable by present-day methods, offer a challenge to the ingenuity of the engineer; the challenge has been accepted and is being answered by a very aggressive research program.

"The training of the students is highly quantitative in nature and classwork is especially adapted to the study of Pennsylvania problems. Full opportunities are given the students to come in contact with the research work carried out on natural gas and the improvement of secondary methods of oil recovery."

L. R. Botsai Promoted by Westinghouse

Louis R. Botsai has been appointed manager of the Gearing Department at the East Pittsburgh Division of the Westinghouse Electric and Manufacturing Company, it is announced by A. C. Streamer, general manager of the division.

For the last three years Botsai has been sales manager of the company's Small Motor Division in Lima, Ohio. Before that he was for eight years sales manager of gearing apparatus at the Westinghouse Nuttall Works in Pittsburgh.

Program Near Completion

Program plans are nearing completion for the regular spring meeting of the Southwestern District, American Petroleum Institute, to be held in Shreveport, Louisiana, February 27 and 28. Latest production engineering developments and national defense will be considered in the general sessions, and a dinner-dance and other entertainment is scheduled. L. Moseley Moffitt, Triangle Drilling Company, Inc., is general chairman of the meeting.

Los Angeles Basin Chapter A.P.I. Meets

The Los Angeles Basin Chapter of the Division of Production of the American Petroleum Institute held a meeting on January 14, in the Shell Oil Company recreation hall, Long Beach.

A round table discussion was conducted on the subject: "Practical Production Problems," led by W. J. "Swede" Larson, production superintendent for Union Oil Company; Fred Miller, superintendent for Continental Oil Company; J. F. (Jim) Gilstrap of California Production Service Company; Paul Andrews, production engineer for Signal Oil and Gas Company; A. F. (Art) Wilson, production foreman for Standard Oil Company of California, and W. A. (Dick) Werts, production superintendent for Hall-Baker Company on Union Pacific properties.

"Three Years Working in the Argentine" was the subject of a talk by Glen Ruby, formerly chief geologist of Y.P.F. (Argentine Government Oil Fields).

G. T. Rockenbough New McEvoy Salesman

McEvoy Company, Houston, Texas, announces the appointment of G. T. Rockenbough as sales representative for the North Texas and Oklahoma

G. T. ROCKENBOUGH

territories. His headquarters will be in Wichita Falls, Texas.

Rockenbough has had 16 years' experience in various fields in Texas, Oklahoma, and Kansas and has specialized in handling surface control and completion equipment. Working under the various conditions encountered in these several fields he has become thoroughly conversant with all completion and control problems of the industry.

His address is 1714 Collins Street, Wichita Falls. The telephone number is 4328.

D. S. Mix in Charge G-E Media and Publishers' Relations

The assignment of responsibility to D. S. Mix for media and publishers' relations, General Electric Publicity Department, Schenectady, New York, has been announced by R. S. Peare, manager of G-E's Publicity Department and Broadcasting. Under his new duties, Mix will have responsibility for work formerly handled by the late F. R. Davis.

A native of New Haven, Connecticutt, Mix was graduated from the Sheffield Scientific School of Yale University in 1917, joining General Electric immediately thereafter on editorial work in the publicity department. The following year he left the company for military service, returning to G-E in 1919, when he was again assigned to editorial work in the publicity department. After promotional work in the commercial service section of the same department, Mix was made a contact man with responsibility for directing the advertising and sales promotion activities of a large number of G-E apparatus lines.

In 1929, Mix was made copy chief of the department in addition to his duties as contact man. Since 1932, he has devoted his time to publicity department training programs, personnel, and special assignments, which he will continue to handle.

California Oil and Gas Association Elects

R. E. Collom, vice-president of the Continental Oil Company, was re-elected president of the California Oil and Gas Association at the December meeting of the association board of directors. Torrey H. Webb, vice-president of The Texas Company, and William Reinhardt, vice-president of the Union Pacific Railroad Company, were re-elected vice-presidents. H. L. Westbrook, vice-president of the Belridge Oil Company, was re-elected treasurer for his 16th successive term. F. E. Foster continues as managing director, and D. S. Kilgour continues as assistant manager.

Directors elected for 1941 include: S. Belither, vice-chairman, Shell Oil Company, Inc.; H. D. Collier, president, Standard Oil Company of California; R. A. Broomfield, executive vice-president, Barnsdall Oil Company; D. S. Faulkner, vice-president, National Supply Company; J. A. Crawford, president, Republic Supply Company; C. R. Gallagher, president, Western States Gasoline Company; E. B. Gilmore, president, Gilmore Oil Company; Dana Hogan, president, Hogan Petroleum Company; C. A. Johnson, president, Holly Oil Company; C. S. Jones, president, Richfield Oil Corporation; W. M. Keck, president, Superior Oil Company; R. B. Lloyd, president, Lloyd Corporation; John McFadyen, vice-president, Ohio Oil Company; Alexander B. Macbeth (retired); A. C. Mattei, president, Honolulu Oil Corporation; F. S. Wade, president, Southern California Gas Company; F. C. Ripley, manager, Chanslor-Canfield Midway Oil Company; L. P. St. Clair, oil administrator; C. P. Watson, vice-president, Seaboard Oil Company of Delaware; A. L. Weil, president, General Petroleum Corporation of California; R. P. Huggins, general manager, Western Gulf Oil Company; Lawrence Vander Leck, vice-president, Fullerton Oil Company; Leigh M. Battson; Joseph Jensen, incumbent president of the Wildcat Committee of the association.

1941
SERVING 10 STATES AND OUR NATION'S CAPITAL
Affiliated NATIONAL HOTELS
35 HOTELS WITH BUT A SINGLE THOUGHT FOR YOU
Happy New Year

A Method for Determining the Water Content of Oil Sands

AN accurate knowledge of the water content of oil-bearing sands now is recognized as an important factor in calculations of the flow of oil through the sands to producing wells and in the estimation of oil reserves. To this end the U. S. Bureau of Mines laboratories are using a method that is an adaptation of the A.S.T.M. method of determining the water content of petroleum products. The apparatus and technique have been altered slightly, however, as described in Report of Investigations 3535, prepared by D. B. Taliaferro and G. B. Spencer, to increase the precision of the method without affecting the simplicity of procedure or speed with which determinations may be made.

Until recently petroleum engineers, when estimating reserves assumed that the entire pore volume of the oil-saturated parts of producing sands was filled with oil, as it was generally thought that the oil, water, and gas in any formation had separated completely during geologic time into distinct layers because of their difference in density. In 1929 Lindthrop and Nickolaeff reported experimental results from which they concluded that 22 to 30 percent of the pore volume of producing sands in the Grozny district, Russia, was filled with water when the fields were discovered. Since that time numerous investigators have found evidence of water in the sands of new oil-producing fields and old fields that never produced water with the oil.

Water was found in sand cores before these investigators made their observations, but it was thought that its presence resulted from contamination of the core by drilling fluid. In 1936 Pyle and Jones determined the extent to which the drilling fluid contaminated cores taken from oil-producing sands. By adding a tracer to the drilling fluid, these investigators found that the amount of contamination of a core from a field in the Los Angeles basin in California was small, yet the core was approximately 38 percent saturated with water. About the same time Lewis and Horner reported the analysis of a core (taken with oil as the drilling fluid) that was found to be 44 percent saturated with water, although no water was used in drilling. More recently Schilthuis has given the results of analyses of cores (taken with oil as the drilling fluid) in the East Texas, Anahuac, and Tomball fields of Texas, which showed that the average water saturation of the oil section in the East Texas field, to a depth of 3285 ft. below sea level was about 10 percent; below this depth the water saturation increased gradually to approximately 30 percent. A core from the Anahuac field had an average water saturation of 50 percent, and two short sections of core from the Tomball field were 49 and 59 percent saturated with water, respectively.

The existence of appreciable quantities of water intimately commingled with the oil in oil-bearing sands has an important bearing on (a) the estimation of total oil in place per unit of reservoir volume, (b) the efficiency of oil recovery by common production methods, and (c) the dynamics of reservoir behavior. With respect to (a) and (b) above, recognition of the importance of the water content of oil sands has changed radically the conception of the completeness with which oil is extracted by ordinary production technique. It is known that the oil actually recovered represents a much higher percentage of the total oil in place than was estimated on the earlier basis; namely that the effective pore space was virtually filled with oil under original conditions.

Experiments on the dynamics of reservoir behavior (c) have demonstrated that a sand containing immobile water will offer more resistance to the flow of oil than permeability tests made on "dry" specimens would indicate. For example, Dunlop found that when the volume of water in the voids of a sand exceeded 15 percent of the pore volume, the resistance to flow of kerosine through the sand increased at a very rapid rate. Wyckoff and Botset noted that the rate of flow of gas through a water-saturated sand increased rapidly as the water content decreased and that when the water content decreased to 10 to 15 percent of the pore volume the gas flow was almost 100 percent.

Having discovered the presence of large quantities of water in oil-bearing sands and its effect on oil production and the estimation of reserves, petroleum engineers began to investigate methods of determining the quantity of water in oil sands. The simplest methods found were to heat a sample of the sand in a suitable container to a few degrees above the boiling point of water and to calculate the water content from the loss in weight of the sample; to condense the water driven from the sample by heat and measure the volume condensed; or to absorb in a drying tube the water released by heating the sample and calculate the water saturation from the increase in weight of the tube. Another method of determining the quantity of water in oil sands is to boil the sample in a liquid—xylene, tetrachloroethane, or toluene—which is immiscible with water and has a boiling temperature above 212°F. The water that is distilled from the sample is condensed and collected in a graduated tube or burette in which the quantity can be determined.

Although these methods have been used extensively for determining the water content of many products, the presence of crude oil and water of crystallization in oil sands makes it necessary to modify the conventional routine methods for determining the water content of core specimens. Several investigators have described methods in which the sample of sand is subjected to heat and the water distilled over into a graduated tube or a drying tube where its volume may be measured by the increase in weight of the tube. Taylor and Botset have described methods for determining the water content of sands that are modi-

ARMSTRONG BROS.

STUB END WRENCHES

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fications of a method used to determine the water content of alcohol, and Horner and Barnes have described a method that is a modification of the A.S.T.M. method for determining water in petroleum products.

After experimenting with several of these methods and comparing the results obtained, the U. S. Bureau of Mines engineers adopted a modification of the A.S.T.M. method for determining water in petroleum products to ascertain the water content of oil sands. The more significant changes in the A.S.T.M. procedure include the following: The size and shape of the trap were altered so that the volume of water collected could be read more accurately; the corks were replaced by ground joints; and toluene rather than gasoline was used as the solvent.

This investigation, conducted by the Bureau of Mines in coöperation with the State of Oklahoma, was made under the general supervision of R. A. Cattell, chief engineer, Petroleum and Natural-Gas Division, U. S. Bureau of Mines, Washington, D.C., and N.A.C. Smith, supervising engineer, Petroleum Experiment Station, U. S. Bureau of Mines, Bartlesville, Oklahoma, and under the direct supervision of W. B. Berwald, former senior petroleum engineer, U. S. Bureau of Mines, Bartlesville.

W. E. Egan of "Oilwell" Has Retired

William E. Egan, manager of Oil Well Supply Company's Denver, Colorado, office, retired on December 31, after 40 years' service with "Oilwell."

WILLIAM E. EGAN

He started with the company at Florence, Colorado. In 1921 he moved to Denver, where he acted as sales representative and also supervised the Florence store until he was made manager of the Denver office in 1928.

Lane-Wells Introduces Radioactivity Well-Logging in Gulf Fields

Radioactivity well-logging service will be available to oil well operators from the Houston, Texas, office of the Lane-Wells Company, according to an announcement made by M. E. Montrose, general sales manager.

Lane-Wells radioactivity well logging is an advanced method of determining bore hole formation characteristics in both cased and uncased holes. Formations are reliably logged through as many as three strings of cemented casing, it is stated. Results are not influenced by the fluid content of the bore hole, and radioactivity logs made in open hole with very salty mud, or with oil base drilling fluid, have full details and are easily correlated with logs made in wells that are already cased.

Los Angeles Nomads Hold Golf Tournament

The first annual golf tournament of the Los Angeles Chapter of Nomads was held at the California Country Club during the morning and afternoon of December 27. Nomads and their guests competed for prizes, which were awarded at the regular monthly dinner that followed the tournament. Among the guests were a number of men from foreign fields who are visiting the United States either on business or vacation. The contest was separated into two groups, one for guests and the other for regular and associate Nomad members. The results were as follows:

Nomads' Guests: Low gross, C. V. Harlow; first low net, Frank Bergeron of Baash-Ross Tool Company; second low net, Lee Laird of Chiksan Tool Company; third low net, D. Bradburry of Howard Supply Company; fourth low net, A. B. Jenks of Fullerton Oil Company; fifth low net, Eddy Ross of Baash-Ross Tool Company; sixth low net, W. H. Pierce of Petroleum Securities Company, and high gross, C. D. Hendershott of N.P.P.M. from Sumatra. Door prize, John Augsburger, of Arthur N. Macrate Oil Company.

Nomads: Low gross, Marris Smith of E. M. Smith Company; first low net, George Trembly of Howard Supply Company; second low net, George Anderson of Baker Oil Tools, Inc.; third low net, G. W. Moore of the Cavins Company; fourth low net, E. B. Fowks of Emsco Derrick and Equipment Company; fifth low net, F. B. Knox of Baker Oil Tools, Inc.; sixth low net, K. R. Catchpole of D. & M. Machine Works, and high gross, Tut Lee of Regan Forge and Engineering Company. Door prize, Shorty Hamer of Hamer Oil Tool Company.

After the dinner the subject of golf was carried further with the showing of talking pictures depicting the fundamental principles of the game.

Foreign visitors who remained for the dinner and evening session included: R. P. Borncamp of Trinidad Leaseholds, Ltd.; H. O. Higgins of the Asiatic from Papua; Charles Hauenstein of Iraq Petroleum Corporation; C. D. Hendershott of the N. P. P. M. from Sumatra; M. H. Bush of Bahrein Petroleum Company; D. T. O'Connor of Bahrein Petroleum Company; Harvey Lytel of Socony-Vacuum Oil Company, recently from Egypt; C. L. Clark of Socony-Vacuum de Colombia; J. A. Castro of Y. P. F. from Argentina; J. A. van Rassell of B. P. M., and J. W. Cunes of B. P. M.

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Book Reviews

1941 Modern Plastics Catalog, published by Breskin Publishing Corporation, New York, N. Y. 476 p., price $3.50.

A complete and authoritative treatise on the plastics industry in the United States, illustrated and organized to make the finding of specific information an easy task.

There are nine main divisions, of which the following six are listed: Plastics Engineering; Materials; Molding and Fabricating; Machinery and Equipment; Laminates, and Plastic Coatings.

A plastics properties chart is included, completely revised, where required through improvement or change in the raw material involved. This chart has become a standard reference in the plastics industry and the fact that constant revisions are made to keep it accurate and up-to-date, makes it all the more important.

The Directory Section of the catalog is considerably larger than that of any previous catalog. It contains the most complete list of custom molders—compression and injection—ever compiled, as well as a list of foreign manufacturers of plastics in Canada, South America and Mexico. The latter is a new feature as is the list of technical, design and vocational schools in the United States that give courses in plastics. The selected bibliography of books and magazines on plastics has been brought up-to-date, as has the chapter devoted to the nomenclature common to the industry. Complete listings with names and addresses of those companies engaged in various phases of the plastics industry are also included, along with a section on molders' markings. There is also a directory of trade names.

•

Fundamentals of Welding Metallurgy. Published by American Welding Society, New York, N. Y., 2 volumes, 375 p., $1.50 per copy.

A very brief textbook on the A, B, C of metallurgy comprising a series of lectures to familiarize members of the welding industry with the composition and structures of the metals commonly used, to show the effect of varied conditions of heat and stress in welding, to explain heat treatment and to illustrate how the knowledge of metallurgy can be used to control the welding processes.

Volume 1 consists of the first series of 10 lectures given in coöperation with the Polytechnic Institute of Brooklyn last year. Volume 2 includes the series of lectures to be given this year.

These lectures have been prepared by Professor Otto H. Henry of Polytechnic Institute of Brooklyn and Dr. G. E. Claussen of the same University, who is also connected with the Welding Research Committee.

Volume 1 consists of: Temperature Changes During Welding, Types of Steels and Their Manufacture, Crystals, How Crystals Grow From Other Crystals, Why Crystals Are Strong, The Weld Melt (Pure Iron), The Weld Melt (Steel), The Iron—Iron Carbide Equilibrium Diagram, Difficulties, The Solid Weld, Rate of Cooling, Alloy Steels, Metallurgical Constants.

Volume 2 consists of: Heat and Time in Welding, The Weld During Cooling, Brittleness and Cracking, Shrinkage, Fluxes and Slags, Alloy Steels, Stainless Steels, Preheating and Stress Relief.

A.S.T.M. Viscosity Index Tables and *A.S.T.M. Conversion Tables for Kinematic and Saybolt Universal Viscosities.*

These tables are of interest particularly in the field of petroleum products and lubricants; the pamphlets include viscosity index tables and conversion tables for kinematic and Saybolt viscosities and provide in durable and convenient form data that are widely used. Each table is based on and amplified from the respective A.S.T.M. standard methods. The tables were originally compiled by the Standard Oil Development Company.

The index tables (36 pages) provide convenient references to the viscosity index, which is an empirical number indicating the effect of change of temperature on the viscosity of an oil. The index calculated from basic Saybolt Universal Viscosity is tabulated against Saybolt at 100°F. under Saybolt values at 210°F. for 40 seconds to 161 seconds.

The viscosity conversion tables (16 pages) afford a quick conversion from kinematic to Saybolt Universal Viscosity. The tables range from 2.00 to 330.0 centistokes (32.60 to 1524.6 Saybolt sec. at 100°F.) by increments of 0.01, 0.02, 0.10, and 0.20 depending on the range. Saybolt equivalents at 210°F. are given for a centistoke range of 2.00 to 75.0.

Each of the tables is bound in extra heavy paper cover and printed on durable stock. The index tables may be obtained in quantities of 1 to 9 at 50 cents each; 10 to 24 copies, 40 cents; 25 to 99, 35 cents; 100 and over, 30 cents. The conversion tables are 25 cents each for 1 to 9 copies; 10 to 24, 20 cents; 25 to 99, 17½ cents; 100 and over, 15 cents.

Copies of the above are available from A.S.T.M. Headquarters, 260 S. Broad Street, Philadelphia, Pennsylvania.

●

Index to A.S.T.M. Standards, 1940-1941. The latest edition of the "Index to A.S.T.M. Standards, Including Tentative Standards" gives information on all the 952 standards as of December 1, 1940. The Index is of service to anyone wishing to ascertain whether the Society has issued standard specifications, test methods, or definitions covering a particular engineering material or subject and it is of help in locating the standards in the volumes where they appear.

All items are listed in the Index under appropriate keywords according to the particular subjects they cover. As a convenience a list is given of the specifications and test in numerical sequence of their serial designations.

Copies of the 172-page publication are supplied without charge on written request to A.S.T.M. Headquarters, 260 S. Broad Street, Philadelphia, Pennsylvania.

●

Practical Accounting for Oil Producers by Robert M. Pitcher. 370 pages; fabrikoid; charts, tables, and forms; published by Mid-West Printing Company, 415 East Fourth Street, Tulsa, Oklahoma. Price, $5.00.

Written as a course of study and as a reference handbook on accounting problems in the producing branch of the petroleum industry, with some data on accounting procedures and forms used in crude-oil purchasing and marketing, pipe-line operation, and drilling. Subjects treated include general ledger, voucher register, cash books and records, imprest funds, depletion ledger, undeveloped lease ledger, producing properties ledger, control of material and equipment pricing, daily gauge reports, pipe-line run tickets, taxation, etc. The volume is designed for use in training accounting department employees in specialized petroleum fields.

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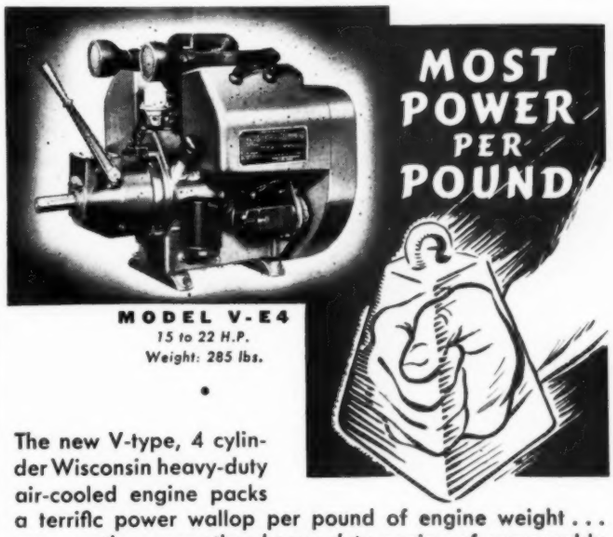

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Trade Literature

GENERAL ELECTRIC COMPANY, Schenectady, New York, has recently issued four bulletins, as follows:

GEA-2964B—The new G-E full-voltage magnetic motor starter designed for machines.

GEA-1542D—Heavy-duty d-c. motors, constant speed, 1 to 60-hp.

GEA-1868B—Heavy-duty d-c. motors, constant speed, 50 to 300-hp.

GEA-3480—G-E frequency-modulation communication equipment.

●

C. J. TAGLIABUE MANUFACTURING COMPANY, Park and Nostrand Avenues, Brooklyn, New York, has issued a new pyrometer catalog, No. 1101F. The publication lists and describes all the improvements made to the Celectray line during the last year. Copies are being sent free upon request.

●

BULLETIN 16-10 has been published by the Buckeye Traction Ditcher Company, Findlay, Ohio, covering their Model 70 ¾-yd. Buckeye Clipper Convertible Shovel. Full specifications are given and the ease of convertibility to dragline, crane, and trench hoe is illustrated. Copies are available on request.

●

THE INTERNATIONAL DERRICK AND EQUIPMENT COMPANY, Beaumont, Texas, has published bulletin No. 1725-23-275 covering Ideco's new streamlined rotaries. Although certain sizes and types of these rotaries have been on the market for almost three years, only recently has the company developed them in all the six sizes and types described in the bulletin. They are now offered for any type of drilling.

●

AMERICAN METER COMPANY has issued a new bulletin on liquefied petroleum gas meters (Catalog LPG-4). Especially helpful is the section devoted to "Specifications for Ordering Liquefied Petroleum Gas Meters." It is based directly upon American Meter Company experience in providing—from the very beginning of the industry—specially-constructed meters in a range sufficiently wide to cover all butane-propane applications.

The booklet confines itself to the essentials of LPG metering practice, is generously illustrated, and designed for easy reference.

●

PLOMB TOOL COMPANY, Los Angeles, California, has issued Catalog No. 18A, which lists and describes, as well as shows illustrations, of its complete list of hand tools. The publication is made still further of value by inclusion of mathematical tables that are frequently referred to. A copy of the catalog may be had by writing to Plomb Tool Company, Box 3519 Terminal Annex, Los Angeles.

●

THE AIRCO NO. 10 PLANOGRAPH, a new 8-page bulletin published by Air Reduction Sales Company, New York, describes this gas-operated cutting machine designed for cutting straight lines, rectangles, circles and irregular shapes from ferrous metal of any thickness within the present practical limits of the cutting torch.

The bulletin contains a complete pictorial representation of the Planograph, as well as operating details and specifications.

Copies of this bulletin may be obtained by writing Air Reduction Sales Company, 60 East 42nd Street, New York, New York.

●

THE NEW FALL 1940 CATALOG of Important Technical and Scientific Books of the Chemical Publishing Company,

Inc., New York, New York, contains many important new titles. Books of importance in all technical and scientific fields have been added to the previous standard and authoritative works. A glance through this new catalog reveals books of interest to the layman, architect, aeronautical engineer, pharmacist, chemist, engineer, metallurgist, advertiser, home gardener, farmer, technician, scientist, etc.

●

WORTHINGTON PUMP AND MACHINERY CORPORATION, Harrison, New Jersey, has recently issued several new bulletins descriptive of their products, as follows:

Bulletin L-611-B11A—Worthington single horizontal 2-stage compressors, steam and motor driven, types HB-2 and HS-2.

Bulletin L-611-B12B—Worthington single horizontal 3-stage compressors, steam and motor driven, types HB-3 and HS-3.

Bulletin W-103-B4A — Worthington horizontal side pot pumps for refinery service.

●

A NEW 20-PAGE STIFF-COVERED BOOKLET giving data for capacitor application on industrial plant circuits, and intended as a permanent reference for the power plant engineer is announced by the Westinghouse Electric and Manufacturing Company. Containing theory, formulae, tables, and charts, the new booklet tells how, where, and how much capacity to apply to circuits for power factor improvement.

Copies of Application Data 49-060 may be obtained upon request from Department 7N20, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

●

DOUBLE SEAL RING COMPANY, Fort Worth, Texas, has recently published the Third Edition of *The Double Seal Piston Ring Handbook*, which is a condensed source of practical information for engineers, machine operators and designers, covering specifications, applications, and recommended types of piston rings. Available from the company at the price of $1.00.

●

LANCASTER IRON WORKS, INC., Lancaster, Pennsplvania, has issued the Third Edition of the *Lancaster Handbook*, giving general data useful in connection with the design and fabrication of steel plate construction. Available from the company.

Horizontal Drilling for Oil and Water

With V. H. Wilhelm, assistant to production manager of The Texas Company and newly-elected chairman, presiding, Leo Ranney described his method of horizontal drilling for oil and water to the American Institute of Mining and Metallurgical Engineers at its regular dinner meeting at the Los Angeles Athletic Club January 10. The meeting was the first since the election of new officers in December.

With C. P. Watson, Seaboard Oil Company, and H. B. Menardi, mining engineer, as vice-chairmen, committee chairmen appointed by Wilhelm are: Leon. W. Huebel, arrangements; D. B. Myers, membership; Thos. C. Bannon, program; Prof. John F. Dodge, preparedness; Thomas Clements, student prizes, and Richard H. Pence, publicity. Leon T. Huebel is chairman of the Juniors, and Lyle Smith is chairman of the Coastal Division.

New Lane-Wells Offices

M. E. Montrose, general sales manager, Lane-Wells Company, announces that branches have been opened at Olney, Illinois, P. O. Box 348, telephone 844, and at Ardmore, Oklahoma, 321 Simpson Building, telephone 751.

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California Wildcats Hold Christmas Jinks

The Wildcat Christmas Jinks program, staged by the Wildcat Committee of the California Oil and Gas Association, was held at the Biltmore Bowl in Los Angeles, December 18. Master of ceremonies was William H. Geis. A feature

Quizzkitty "experts," left to right: L. L. Aubert, Mark D. Woolery, W. C. Brooks, and Ward B. Blodget

of the affair was the "Quizzkitty" broadcast, patterned after "Information Please." The accompanying illustration shows the "experts" who answered all the questions put to them. That it was subsequently revealed that they had been talking into a dummy mike and had not been on the air at all added greatly to the hilarity of the occasion.

Fred R. Davis, G-E Advertising Man and A.B.C. Founder, Dies

Fred R. Davis, a founder of the Audit Bureau of Circulations and advertising space buyer for the General Electric Company, Schenectady, New York, for 35 years, died December 26 at his home in Schenectady after an illness of two years. He was 64 years old. For many years he supervised the expenditure of more than a million dollars annually for newspaper and magazine space.

A man of scientific training himself, Davis was a pioneer advocate of accurate measurement in advertising and helped found the Audit Bureau of Circulations in 1914. He served as a director from that date until his death and since 1927 had also been first vice-president of the organization.

Davis was born in Adams, Massachusetts, attended Union College in Schenectady, and was graduated from Worcester Polytechnic Institute in 1900 with the degrees of B.S. and M.S. in engineering. In 1901, he entered the G-E organization as a test student and in 1902 went to Fort Wayne, Indiana, as publicity manager of the Fort Wayne Electric Company. In 1905 he joined the G-E advertising department in Schenectady.

He was an elder of the First Presbyterian Church of Schenectady, a member of the Technical Publicity Association, and a member of the Phi Gamma Delta fraternity.

United Gas Employees Entering Military Service to Receive Three Months' Pay

Employees of United Gas Pipe Line Company and associated companies who enter the military service of the United States either by enlistment or selection under the National Guard and Selective Training and Service Acts of 1940 will receive three months' pay, a year's leave of absence, and other benefits, according to an announcement by company officials.

MEETINGS

California Natural Gasoline Association, Monthly Meeting—February 6, Barker Bros. Auditorium, 818 West Seventh Street, Los Angeles, California.

American Institute of Mining and Metallurgical Engineers—February 17, 18, 19, and 20, Engineering Societies Building and Commodore Hotel, New York City.

North Texas Oil and Gas Association—February 22, Wichita Falls, Texas.

Liquefied Petroleum Gas Association, Annual Convention—February 24 and 25, Chicago, Illinois.

American Petroleum Institute, Southwestern District Division of Production—February 27 and 28, Washington-Youree Hotel, Shreveport, Louisiana.

American Society for Testing Materials—March 3, 4, 5, 6, and 7, Hotel Mayflower, Washington, D. C.

American Petroleum Institute, Division of Production, Spring Meeting, Pacific Coast District—March 11, Biltmore Hotel, Los Angeles, California.

Indiana Independent Petroleum Association, Spring Convention and Refiners' and Suppliers' Exhibit—March 11, 12, and 13, Hotel Severin, Indianapolis, Indiana.

Oklahoma Utilities Association, Annual Convention—March 17 and 18, Tulsa Oklahoma.

American Association of Petroleum Geologists—April 2, 3, and 4, Rice Hotel, Houston, Texas

American Chemical Society—April 7, 8, 9, 10, and 11, St. Louis, Missouri.

Midwest Power Conference — April 9 and 10, Palmer House, Chicago, Illinois.

Southwestern Gas Measurement Short Course—April 15, 16, and 17, University of Oklahoma, Norman, Oklahoma.

Western Petroleum Refiners Association—April 16, 17, and 18, Arlington Hotel, Hot Springs, Arkansas.

American Petroleum Institute, Eastern District, Division of Production — April 17 and 18, William Penn Hotel, Pittsburgh, Pennsylvania.

Petroleum Industry Electrical Association—April 23, 24, and 25, Tulsa, Oklahoma.

Natural Gasoline Association of America, Annual Meeting—April 23, 24, and 25, Baker Hotel, Dallas, Texas.

National Petroleum Association—April 24 and 25, Semi-annual Meeting, Hotel Cleveland, Cleveland, Ohio.

Petroleum and Natural Gas Conference—April 25 and 26, State College, Pennsylvania.

American Gas Association, Natural Gas Section—May 5, 6, 7, and 8, Dallas, Texas.

American Petroleum Institute, 11th Mid-year Meeting—May 19, 20, 21, 22, and 23, Mayo Hotel, Tulsa, Oklahoma.

Illinois-Indiana Petroleum Association, Ninth Annual Petroleum Conference—June 7, Robinson, Illinois.

American Society of Mechanical Engineers, Petroleum Division, Annual Meeting—June 16, 17, 18, 19, and 20, Kansas City, Missouri.

American Society for Testing Materials—June 23, 24, 25, 26, and 27, 44th Annual Meeting, Palmer House, Chicago, Illinois.

American Petroleum Institute, 22nd Annual Meeting—November 3, 4, 5, 6, and 7, San Francisco, California.

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DESIGN & CONSTRUCTION

of these tools—how we put into each Cavins 'Performance Plus' tool, the very best of materials and mechanical skill . . . the specialized design and precision engineering for the specific type of service involved. There are nine different sizes to select from—ranging from 1¼ O.D. size for piano wire work to the large 5½ O.D. size. Also, you would appreciate the easy

AVAILABILITY

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PERSONNEL:

Each Cavins branch is staffed by trained men who are genuinely interested in seeing your particular job completed the way you want it completed . . . quickly, thoroughly and economically. Your problem is their job.

Call your nearest Cavins representative before you have another clean-out job, and get full information on Cavins tools and service.

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LONG BEACH, CALIFORNIA

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